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The PRACTICAL ENGINEER

VOL. VI. PHILADELPHIA, MARCH, 1902. NO. 2.

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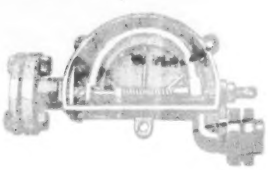

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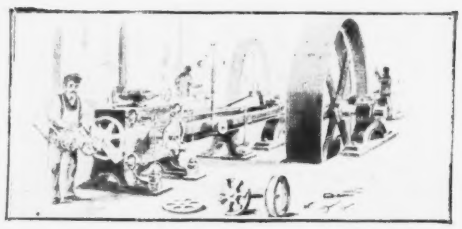

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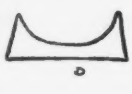

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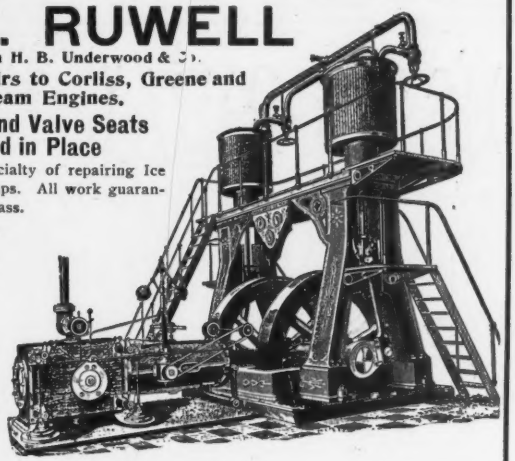

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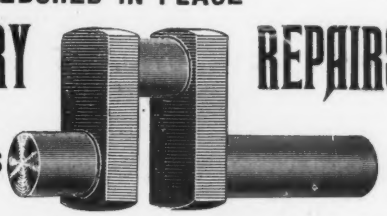

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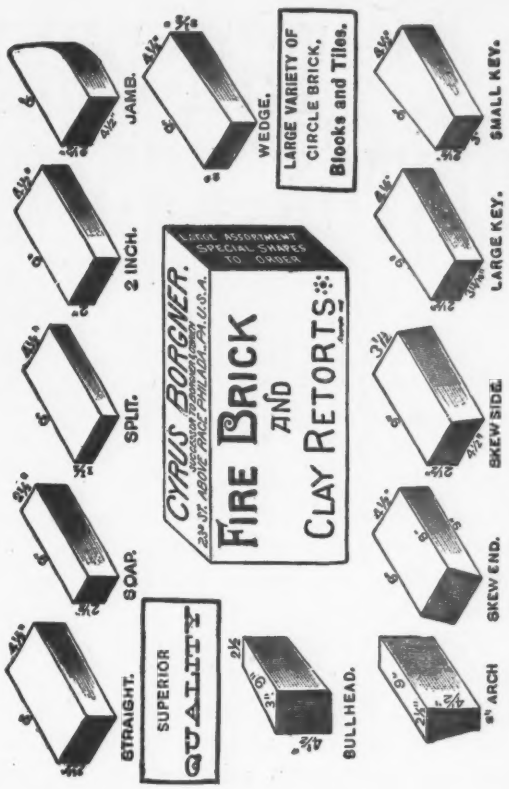

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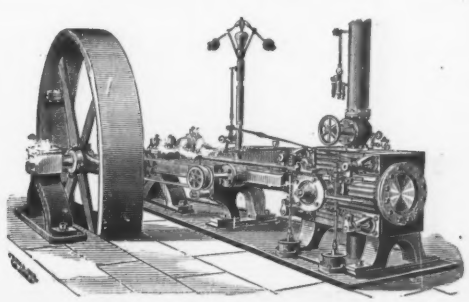

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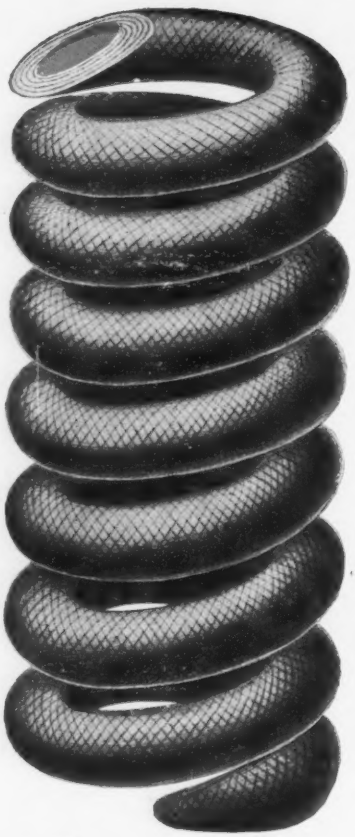
Yours truly,
ALFRED LARSON,
Chief Engineer, Escanaba Water Works



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The Practical Engineer

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OFFICIAL JOURNAL
OF THE
AMERICAN ORDER
OF STEAM ENGINEERS.

Devoted to the Interests of Stationary Engineers.

VOL. VI. PHILADELPHIA, MARCH, 1902. No. 2.

Friction Horse Power.

When we speak of the horse power of an engine, without any further limitation of the term, it is commonly understood that the indicated horse power is meant. There are, however, a number of other terms, also known as horse power, which must be clearly and specifically named to avoid confusion and misunderstanding.

And of these, the one which most concerns the power user is the actual horse power. By actual horse power is meant the power at the crank shaft, or the power which is available for doing useful work.

The latter, often known as the brake horse power also, is considerably less than the indicated horse power, as would be expected. The ratio of brake to indicated horse power forms what is known as the mechanical efficiency, or the percentage of energy supplied to the engine in the steam which is converted into power that can be used externally to the engine and independently of it.

The difference between the indicated horse power and the actual or brake horse power represents the power which is lost in the engine itself. These losses come about in various ways. There is friction of rods in stuffing boxes, friction of piston and cylinder, valve friction, friction of bearings, and the wind resistance to the flywheel, all of which are combined in the one general term, friction horse power.

To determine the mechanical efficiency of an engine, it is necessary, then, to know either the actual horse power or the friction horse power, and the indicated horse power. The latter is easily determined, but to get the actual horse power or that lost in friction may prove more difficult.

If the engine is in such a position that a brake can be attached and the output of power thus measured, it will be a simple matter to find the brake horse power, the mechanical efficiency, and the friction horse power. But there are many engines to which it is impossible to attach a brake, on account of the absence of band wheels or difficulties in location.

In cases like this, an approximate friction horse power may be obtained by running the engine light, or unloaded, at its usual working speed. Indicator cards taken from the engine under these conditions will show simply the power required to overcome the frictional resistances of the engine itself. As just stated, though, this is only approximately correct, since the friction will vary with the load and different conditions of running. So, while the method just outlined will give the true friction horse power at no load, it will not give the correct friction loss at higher loads.

Where it is desired to know the amount of power absorbed by an engine in friction, at any and all loads, the only satisfactory method is to find the indicated horse power corresponding to various brake loads, and to take the difference at these various points. From these results a curve of friction horse power may be drawn, if desired, which will show at a glance the loss in friction at any load.

Suppose the engine was of 120 horse power, we should make at least six tests: one each at 20, 40, 60, 80, 100 and 120 horse power brake load. Each of these tests should last about five minutes, indicator cards being taken every minute and a half or two minutes, as well as the number of revolutions per minute and the brake readings.

Concerning the Study of Automatics.

The wide-awake steam user of today is slowly but surely being won over to the fact that the automatic machinery system is undoubtedly, in most instances, making a great showing in the matter of economy throughout his entire plant. Thus it only becomes a matter of time until the question asked will be, "Which can we obtain the best results from?" and not an absolute refusal to try anything automatic as has undoubtedly been largely the custom in the past.

That automatic devices are looked upon with prejudice, and in some cases with unreasonable aversion, by the many engine-room employees, is evidenced by their actions toward such things in general, and it can be truthfully said that the greatest difficulty experienced by the manufacturers in

placing their appliances is the overcoming of this feeling upon the part of the employee; be the apparatus what it may, the mechanism ever so perfect, or the action ever so certain, results cannot be obtained therefrom without the honest and intelligent co-operation of the attendant. It is only fair for us to say that this feeling of antipathy is slowly but surely dying out, but there is still in a large degree a strong feeling existing against such appliances.

Just why this is true is scarcely explainable, for all such devices of merit are surely lightening the load of labor and increasing the efficiency of the plant, without in any way injuring those directly connected therewith. For instance, the Carnegie Steel Company have a plant at Duquesne, Pa., in which a battery of twelve boilers is being operated, in so far as is possible, by automatic devices. First, the pumps are governed automatically, the introduction of the feed-water is obtained in the same manner with an admirable regulator which insures a fixed water line; the coal is fed through a hopper to an efficient automatic stoker, while the ashes are in a like manner carried from beneath the grates and deposited in a small car, there to await proper removal.

The question may arise, "Well, where does the employee benefit through all that; it probably takes only half as many men to operate the plant, and look at the men thus thrown out of work?" It is probably true that it only takes half the men to operate such a plant, but with the installation of such machinery it becomes a question of the survival of the fittest, for it takes men of intelligence to operate such places. Where muscular strength was once an essential, it now becomes more a question of brains, and brains always commands a higher salary. Thus it will be readily seen that automatic mechanics as introduced in the steam plant not only insures a longer life to the boiler, a better return from coal in the matter of heat, a more efficient and cleanly method of operation, and also a surer means of protection from accidents, and numerous other advantages, but also it is creating a new profession for the fireman. The man who will take an interest in and study such things will of necessity be in demand, for above all else expert attention is necessary, while those who at the present time (and there are many) whose only ambition seems to be to shovel coal will be relegated to their proper sphere, and the man who is earnest in his desire to advance will be elevated above the back aching, back breaking labor resultant from primitive methods.

No matter how careful or industrious the man may be, yet he cannot act with the precision or regularity of a correctly made machine. There is no doubt that there are many devices being marketed which will bear a great deal of improving before they can be accepted, but therein lies the value of a skilled engineer, and again it is not good judgment to accept such things without first subjecting them to a fair test.

It should be the desire of the engineer to meet and talk with salesmen at all times when possible, for be he ever so well versed in his profession he will often learn from the traveling man. In all cases a good salesman is an observer, and will have picked up points during his travels from engine room to engine room that would be of value to any one, hence it will be well to encourage the salesman, and find out what he has. You may not be in need of it at that time, but remember you may not always be in that place, and if you are well versed in the different grades of material, kinds of machinery, and the various appliances analagous to your profession, you will be the man sought after by both the employer and salesman; the employer because you have the knowledge, and the salesman (if he has a sincere conviction of the merit of his article) because he feels that he will be given an honest opinion and a fair trial.

It is not our intention to urge upon anyone the necessity of adopting any article or device, but merely to point out a subject that will bear the most careful study and consideration upon the part of engine-room employees, from the coal passers to the superintendent.

Look at the great number of successful labor saving appliances now on the market, and consider the enormous benefits accruing therefrom. What would the locomotive be without an injector? Yet Giffard, the inventor, labored for years trying to get even a chance to try it, and was met on every side by the opposition of the locomotive engineers, ninety-nine out of every hundred positively declining to take out an engine equipped with an injector. To-day it would be difficult to induce any man to run a locomotive equipped with the old style pump.

Look at the ease with which a train of cars can be controlled with the automatic air-brakes, yet the application of them was fought most bitterly by the very people whom it is now benefiting most. Through the agency of electrical energy the movements of our huge ocean greyhounds are governed with the greatest of ease. In fact, innumerable are the automatics which are to-day easing the labors of mankind despite the opposition of those benefitted.

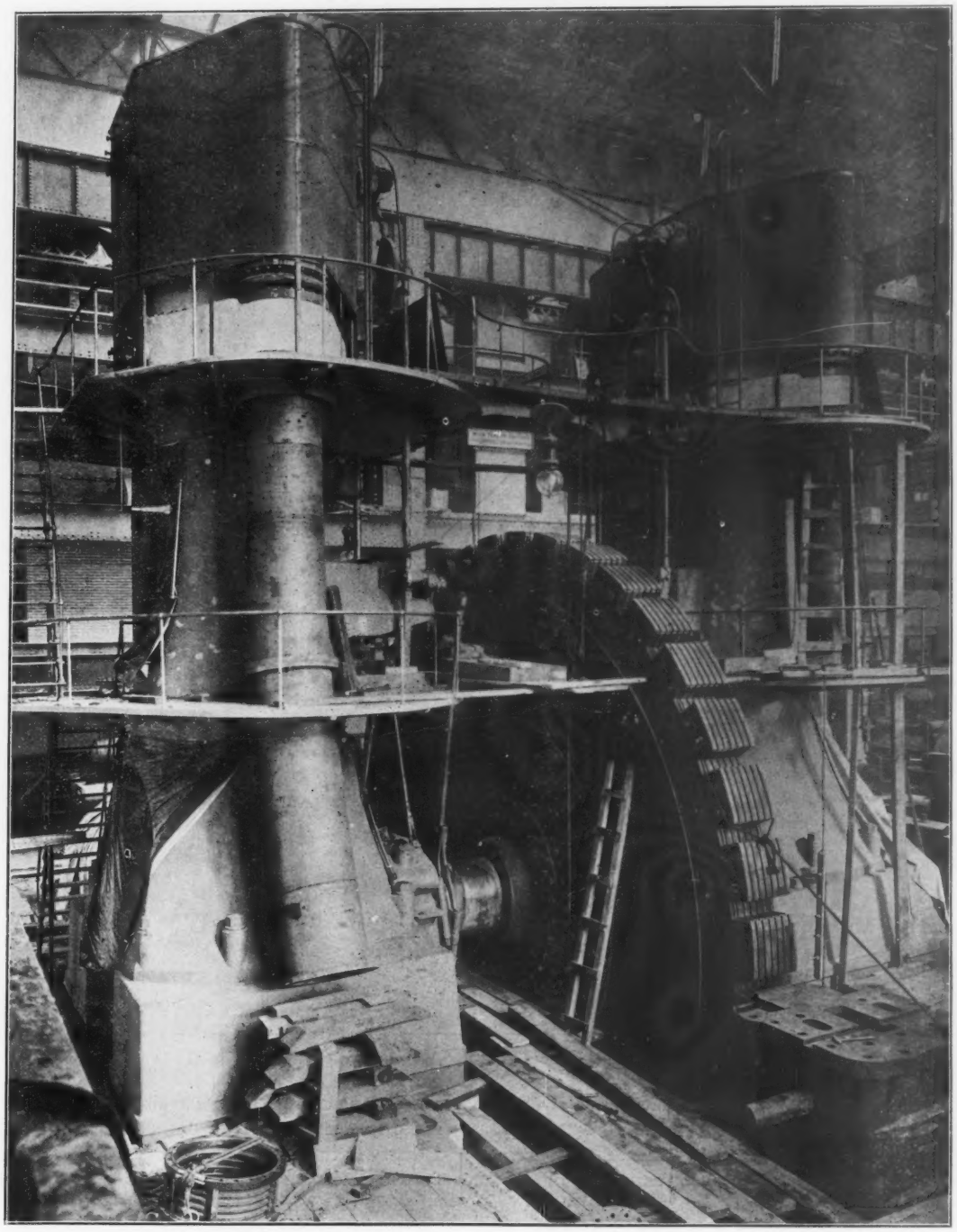
Now while the benefits of these improvements extend to all indiscriminately, what class is more deserving of every consideration and benefit that may accrue from the application of automatic and labor-saving devices than is our firemen and engineers? Surely it is those very people who should welcome anything that will in any way lighten the load of labor.

There is nothing which causes the fireman such serious reflections, as when attempting on a good hot summer day to get a clean fire by the aid of poker and slice-bar, knowing all the time that, with the furnace door open, his steam is rapidly falling, and realizing the need of extra exertion necessary to get it up again; oft times as he stirs the red demons within would he be glad to welcome the automatic stoker.

Automatic damper regulators too have stepped in to save many a weary step and the burning of many unnecessary tons of coal, and thus we could go on and on enumerating the benefits of like devices, each and every one of which had to fight against the most bitter opposition from those who to-day are enjoying the results of their success.

The 60,000 H. P. Plant of the Manhattan Railway Co., New York City.

Truly this is the electrical era. Not in the world's history has any discovery or invention assumed in such a short space of time the mighty proportions as has that of electricity. Each year it is persistently and insidiously supplanting steam in many ways. Especially is this true in the matter of transportation.



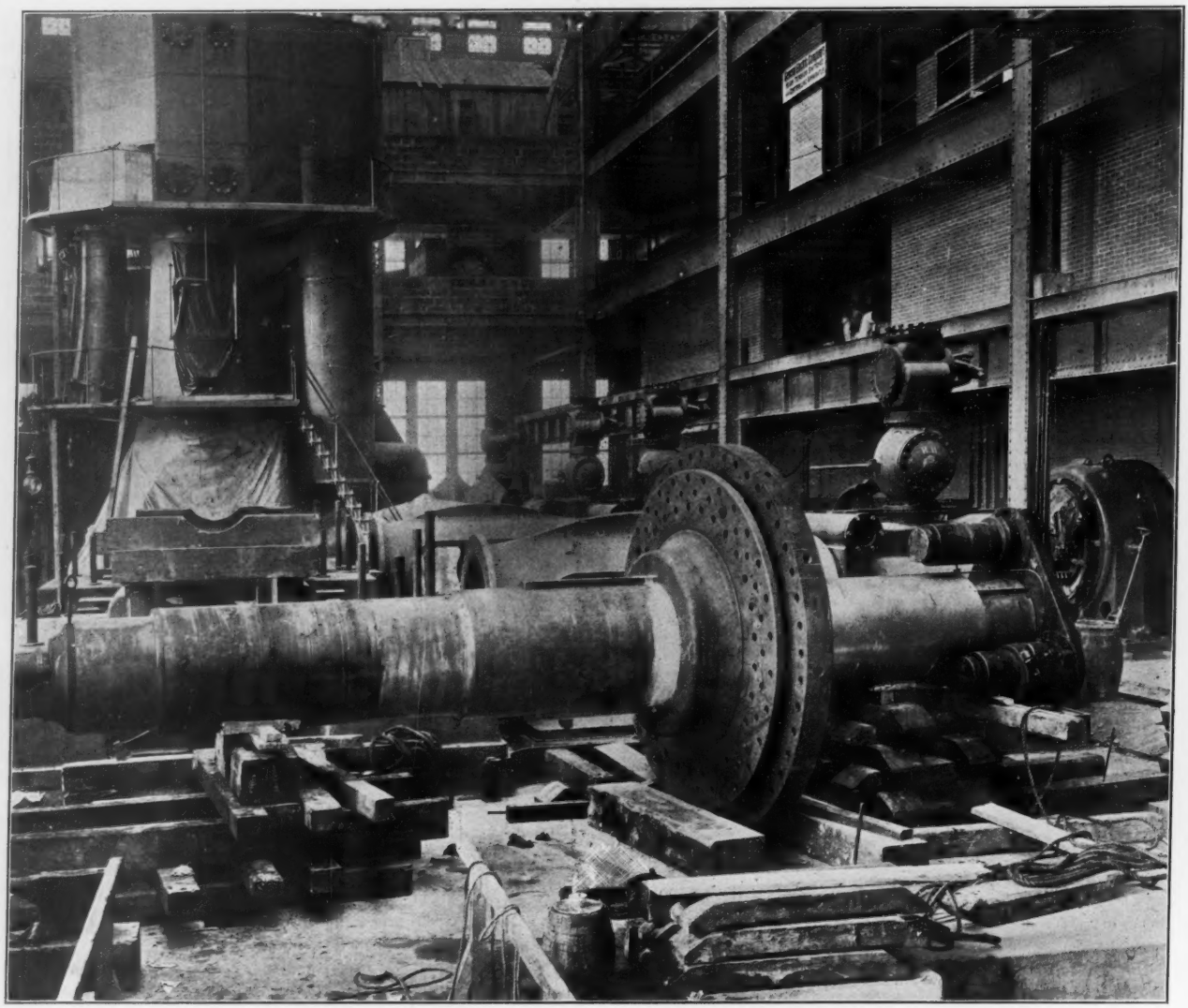
Revolving Field of the Alternator and 12,500 Horse Power Engine.

Fifteen years ago a trolley car was a subject of open-mouthed wonder; to-day we see it installed, not only in the place of many steam railways, but in places where steam roads would be an impossibility. This has been very clearly demonstrated by the action of the management of the Manhattan Elevated Railway Company in assuming sufficient confidence in the electrical method of equipment to substitute it for the steam locomotive upon its enormous system. The magnitude of the undertaking and character of the work to be performed necessitated the utmost confidence in those delegated to manufacture and install this equipment. More surely was this confidence necessary in the matter of the electrical apparatus, as never before had a project of such gigantic proportions been attempted.

After long consideration this confidence was placed with the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. The rapid fulfillment of the contract and the unprecedented results obtained in the matter of construction, shipment and erection of such a mighty mass of machinery, denote that the confidence was well reposed. Some idea of the enormity of the undertaking may be had from the accompanying illustrations and description of the plant.

The equipment represents the most marked advance in electric traction during present years. This statement will be more vividly appreciated if we refer to figures showing the magnitude of the traffic on this road. During the year ending June 30, 1899, the Manhattan Railway carried more than 174,000,000 passengers, as against 38,000,000 carried by one of the greatest trunk line systems in the United States. While much of the latter was long haul traffic, it is probable that the Manhattan Railway has to its credit the greater number of passenger miles. Two million passengers can be carried in a day, This represents the movement of over two hundred trains daily, requiring an expenditure of energy varying from 5,000 horse-power at the hours of minimum load, to 60,000 horse-power at the hours of maximum load. To maintain the latter output for a day would require, as has been pointed out, the combined efforts of 3,000,000 men.

The problem of generating so large an amount of energy was novel in its magnitude and of special importance on account of the delays and widespread inconvenience that would be caused by any breakdown in the generating plant. At the same time, a plant of this size offered great scope for the saving of labor and fuel. Considerations of reliability and economy therefore led the designers of the power distribution system to enter into an exhaustive study of the problem presented in electric power station design. We will take up particularly in this article the factors relating to the design of the electric generators, the type of which was shown after a careful study of the nature of the service required.



Driving Shaft, showing Web Method of attaching for the Revolving Field.

The size of the generating units was determined by the minimum load existing during the early morning hours, from two to five o'clock, which is somewhat less than 5,000 Kw. This was taken as the capacity of the individual units in the station, although it involved the building of larger electrical machines than had ever before been undertaken. The number

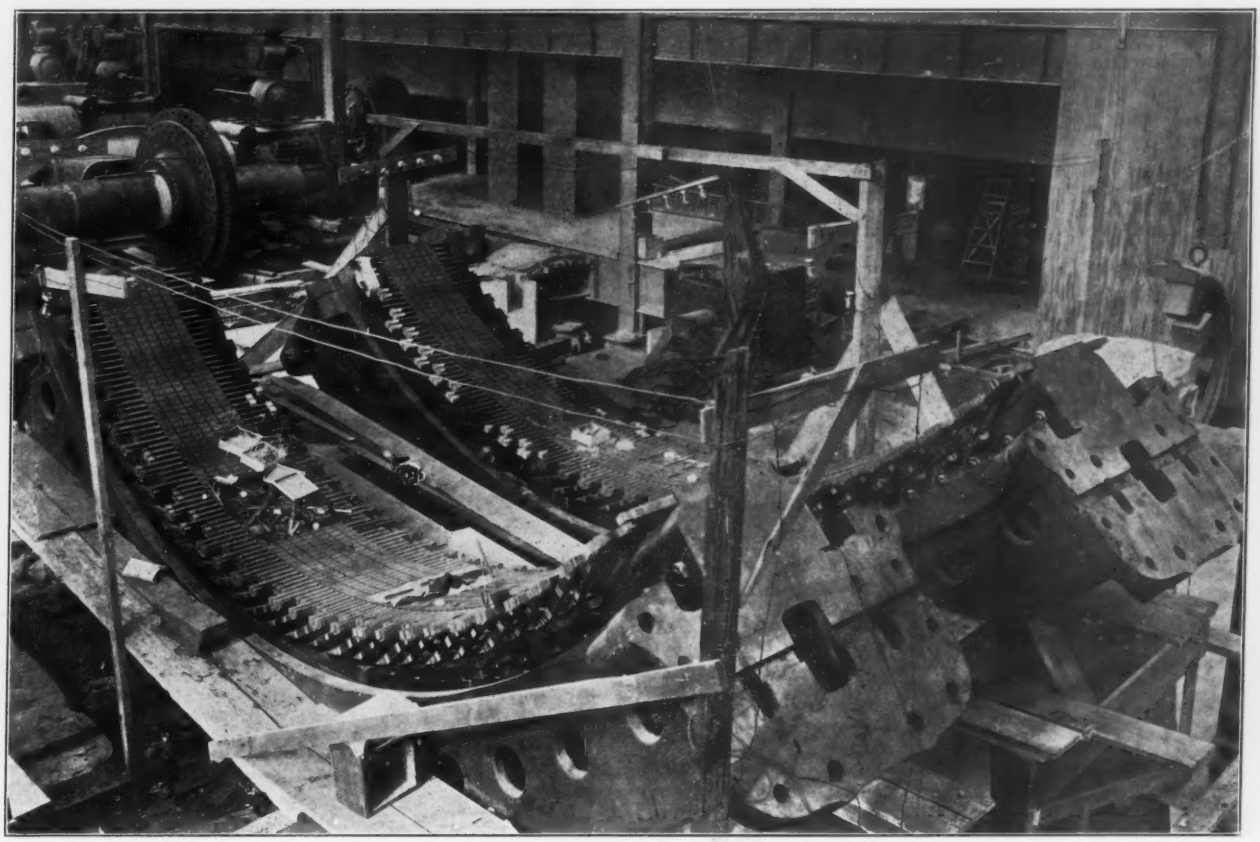
of the units was determined by the maximum load, for which eight machines were considered sufficient.

Since there must be great durability and freedom from breakdown, and also large overload capacity, a slow-speed type of four-cylinder, cross-compound engine was adopted. In order to make the turning movement as uniform as possible, two of the engine cylinders were placed in a vertical position and two horizontally, and by further making the revolving part of the electric generator exceptionally strong and heavy it was possible to dispense with the usual fly-wheel. The extreme variation in speed will not be greater than three-fifths of one degree per revolution; that is, a point on the rotating part will not go ahead or fall behind a point having absolutely uniform motion more than three-tenths of a degree.

For distributing energy from a central power-house over the entire island of Manhattan an alternating current sytem was desirable in order to reduce the cost of transmission lines. The frequency of the system was selected with reference to the use of retary converters, which will be employed for converting the alternating current to direct current for distributing through the third-rail to the trains. Rotary converters operate more satisfactorily at low frequencies, and there being in this case no reason for adopting a high frequency, twenty-five cycles per second was chosen by the engineers of the Manhattan Company as the standard. The regulation of the converter system is further enhanced by the massiveness of the moving parts of the generators and the uniformity of turning moment of the engines, referred to above.

As is common in alternators of large size, in these machines the field is the rotating member. It has been designed with especial regard to mechanical strength, the field magnets with their windings forming the rim of a huge wheel (as shown in cut), which is attached by web plates of rolled steel to a cast-steel hub keyed directly to the engine shaft. This revolving field is thirty-two feet in diameter and, since it turns at seventy-five revolutions per minute, its peripheral speed is 7,540 feet, or more than a mile, per minute. Its weight is 370,000 pounds.

There are forty field poles, built up of laminated steel. They are wound with copper strap on edge, one layer deep, and the insulating material cemented in place between the turns. The edges of the strap are exposed in order to better dissipate the heat developed. The normal exciting current for each alternator field is approximately 225 ampers at 200 volts, and the winding is so designed that the excitation can be increased to care for an overload of fifty per cent and a ninety per cent power factor. The field windings are held upon the poles by copper wedges driven between the pole tips. These wedges also serve to prevent the shifting of the magnetic lines of force, and hence preserve constant the wave form generated.



Portion of Armature of 5,000 Kw. Alternator showing method of winding.

The armature consists of six castings belted together, to which is attached the armature core. The latter is a built-up ring composed of thin, soft steel plates with slots on the inner surface in which are placed insulated copper bars, constituting with their end connectors the armature winding. The steel plates are separated at intervals by ventilating spaces, which prevent the iron from becoming too hot from the effects of hysteresis and eddy-currents.

In order to produce a wave form free from irregularities and

of the same shape at different loads, a distributed winding with four armature slots per phase per pole was adopted. This tends to avoid the production of harmonics, which is an especially important matter in view of the large capacity and self-induction of an extensive system of cables and transmitting apparatus, together with the presence therein of a large number of 1500 Kw. rotary converters. Each slot contains three bars, which are securely fastened to the end connectors. The bars in any slot may be removed without disturbing the bars in the other slots and without moving the frame of the machine. The armature conductors are insulated to withstand a puncture test of 25,000 volts alternating current for thirty minutes.

The building of generators of such exceptional size is a matter of considerable interest. It will be readily understood that only shops of unusual size, and with exceptional facilities, can handle such work. The Westinghouse Electric and Manufacturing Company, who have always been keenly alive to probable development in electric matters, had anticipated the demand for these large units, and one aisle of their great shops, seventy feet long by 1200 feet, is capable of caring for even such large work as that involved in the building of these huge 5000 Kw. machines. Extending entirely through this aisle is a railway siding for convenience in shipping and unloading. To handle the heavy parts of the machinery and the portable machine tools three overhead electric traveling cranes are provided, each having a capacity of fifty tons. All tools in the Westinghouse shops are electrically driven, and some are provided with auxiliary motors for adjustment. Among these is a boring mill which is the largest of its kind ever built. A twenty horse-power motor is used to raise and lower its sixty-ton cross-head. This machine is being used to turn down the field rims of the alternators above described.

The armature frame of one of these huge generators is assembled and bored at one time. The magnitude of this operation will be comprehended when it is remembered that the diameter of the bore is thirty-two feet, and that the frame of the generator stands forty-two feet from the bed-plate to the top, and weighs 550,000. For shipment from the works it is necessary to divide the frame into six parts in order to keep barely within the clearance limits of railway tunnels and bridges, and, as it is, cars of special design had to be used to carry the parts to New York.

The electrical features are unusually noteworthy. Each generator will deliver three-phase currents at 11,000 volts, which if necessary may be raised to 12,000 volts. The wave form generated is practically a true sine curve under all conditiods of load and power factor, and the regulation from full load to no load is guaranteed to be within six per cent. The rise in temperature above the surrounding air of any part of the machine under full load for twenty-four hours is not to exceed 35°C., and at fifty per cent overload, or 7500 Kw., is not to exceed 55°C. The efficiency at full load, from engine to switchboard, is 96.5 per cent.

The magnificent machines are, as above noted, the largest in the world, and they exemplify in a striking manner the triumph and progress of electrical engineering. That they embody the latest and best development in generator design for great traction power houses is shown by the fact that this type of machine was recently chosen for the equipment of the New York Rapid Transit Railway. The contract signed with the Rapid Transit Subway Construction Company calls for six units of 5000 Kw. each.

The Quality of Steam.

R. T. Strohm.

The use of the term "saturated" as applied to steam is, in a way, unfortunate, inasmuch as it conveys an idea of wetness when such is not necessarily the case. Commonly, when we speak of saturation, we mean that the body or substance in question has absorbed as much liquid or moisture as it can possibly hold. Air is saturated when it contains so much water vapor that any further attempt at adding moisture would be followed by precipitation. Cloth is saturated with a liquid when the point has been reached at which it will no longer absorb any more of the liquid.

When steam is spoken of as being saturated, however, it is not saturated with moisture. It is saturated with heat. Enough heat has been added to the water to just convert it all into dry steam. The slightest loss of heat while in this condition will cause some condensation, and any further addition of heat will cause superheating, assuming that the steam is not in contact with the water from which it was generated.

The steam which is formed in the ordinary steam boiler, or the vapor used in the greater number of steam engines throughout the country, is far from being pure saturated steam. Owing to impurities in the water, and consequent foaming, or the spraying effect of the ebullition, or as the result of condensation, there is more or less moisture contained in the steam, either in large globules or as a very finely divided mist.

Consequently steam may be either wet or dry saturated, according to the amount of moisture it contains. If there is no moisture whatever suspended in it, it is dry saturated steam. If, on the contrary, it entrains particles of moisture, it is wet saturated steam. It is to this latter class that by far the greater part of the evaporation of the present-day steam boilers belongs. Absolutely dry steam, without superheating, or dry saturated steam, is a comparatively unknown article in common practice.

However, a line has been drawn, for commercial purposes, which marks the division between wet and dry steam. Since absolutely dry steam is a practical impossibility, it has become a general practice among steam users to consider as dry steam all water vapors containing less than three per cent, by weight, of water. Under this ruling, there are numerous boilers which are furnishing to their engines commercially dry steam, though doubtless there is quite a large number which furnish steam a great deal wetter than this.

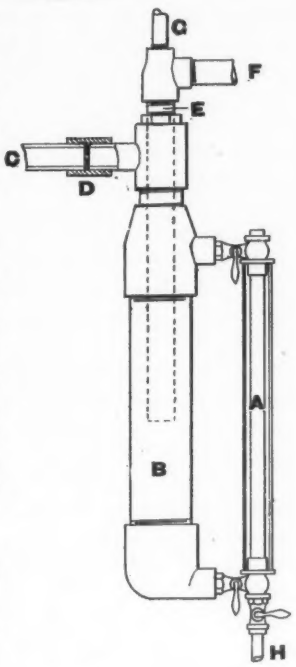
When it comes to the determination of the water consumption of an engine or the evaporative efficiency of a steam boiler, it makes a great difference as to how much water is contained in the steam. It is customary for the buyer of an engine to specify in his contract with the builder the maximum allowable water consumption per horse power per hour, with, in some cases, a premium for performances less than this fixed limit.

Now, when the steam contains moisture, that moistures goes through the engine with the steam, doing no useful work, decreasing the effective effort, spoiling the efficiency of cylinder lubrication, and adding to the water consumption of the engine. In a case, therefore, where an engine is to be bought or sold because of its coming up to its guaranteed steam consumption, allowance must be made for the amount of moisture which that steam contains.

A case is on record, which occurred in Paris before the late exposition, that aptly illustrates this point. Certain American engines were installed in one of the exposition buildings for purposes both of exhibition and power. The engines were tested by a party of several French engineers, and were found

to have a water consumption of more than 30 pounds per indicated horse power per hour, which was excessive, considering the type and class of engine. It had been built under a guarantee of 23 pounds.

An American engineer, surprised at the result of this test, and doubting its accuracy and fairness, examined into the conditions and methods of the trial. He found that the steam supply was furnished through an unprotected iron pipe over 125 feet long. He at once had the pipe properly covered and a steam separator of approved pattern installed in the main near the engine. Tests made under the improved, normal conditions showed a steam consumption of slightly less that 22 pounds per horse power per hour.



In boiler trials the total apparent evaporation is not to be considered as the performance of the boiler. The results must be corrected for moisture which has been carried out with the current of steam and which cannot be considered as evaporation.

This variation in the wetness of steam has given rise to the phrase "quality of steam," by which is meant the percentage of vapory mixture which is dry saturated steam. Thus, if the quality of steam is spoken of as being 95 per cent, it is known at once that it is steam which is 95 per cent dry, or which has 5 per cent of moisture.

There are numerous devices by which to determine the amount of moisture which steam possesses, but they are all included in the term "calorimeter." The principles upon which they act are different, and for that reason each must be separately described. It is not the intention, though, to describe every type, but only such as are most common or give the most accurate results.

The simplest in construction as well as the cheapest of the kind is the barrel condensing calorimeter shown in the first figure. It can be rigged up, at comparatively small expense, in almost any steam plant, since most of the articles used in its construction are usually at hand.

It consists of a wooden barrel placed upon a pair of platform scales which weigh accurately to the quarter pound. Into this barrel is led a pipe, either of iron or a piece of rubber hose, from the main containing the steam to be tested. The barrel should contain somewhere in the neighborhood of 300 pounds of water, at ordinary temperature. If it is desired to be as accurate as possible, the barrel may be covered with a lagging of some good non-conductor to prevent radiation.

In making a test for the quality of steam with this calorimeter, the weight of the water in the barrel is first closely determined and its temperature taken. For this purpose a thermometer is necessary, and this should be a very reliable instrument, capable of reading to a tenth of a degree on the Fahrenheit scale.

Now blow steam through the pipe into the air until the pipe is thoroughly heated. Then turn the current of steam into the water in the barrel, keeping the end of the pipe near the bottom of the barrel, so that all steam issuing will be condensed. While the steam is being run in, the water should be stirred thoroughly with a wooden paddle, so as to obtain a uniform temperature throughout the water. When the temperature has risen to about 120° Fahr. the flow of steam should be stopped and the steam pipe removed. At the same time the temperature of the water should be taken and the weight also. We now possess the necessary data for the calculation of the quality of the steam. This may most easily be shown by the formula

$$Q = \frac{x}{w} = \frac{W(t_2 - t_1)}{wl} - \frac{t - t_2}{l}$$

In this equation, Q is the quality of the steam; x is the number of pounds of dry steam; W is the weight of cold water in the barrel at first; w is the difference between the first and last weights of water in the barrel; t_2 is the final temperature of the water in the barrel; t_1 is the original temperature of the water; t is the temperature of the steam being tested, which can be obtained from a steam table; l is the latent heat of the steam at the pressure in the steam pipe, which can also be found in the steam table.

It is not difficult to see how this formula will give the quality of the steam. The water in the barrel is raised in temperature, by the condensing of the steam, from a temperature t_1 to t_2; and it takes one heat unit to raise one pound of water 1° Fahr. in temperature. So to raise w pounds from t_1 to t_2 will require $w(t_1 - t_2)$ heat units.

The steam that enters is composed partly of dry steam and partly of moisture. Each pound of dry steam gives up its latent heat in condensing, so that x pounds will give up xl heat units.

The moisture thus formed, together with the moisture originally in the steam, at the temperature of the steam, are now lowered from t to t_2, giving up $w(t - t_2)$ heat units more, since w is the number of pounds of water run in, and $t - t_2$ the number of degrees through which this water cooled.

Now, the heat given up by the steam which enters is all taken up by the water in the barrel, and so it must be that

$$xl + w(t - t_2) = w(t_2 - t_1), \text{ or,}$$
$$xl = W(t_2 - t_1) - w(t - t_2)$$

That is, $$x = \frac{W(t_2 - t_1)}{l} - \frac{w(t - t_2)}{l}$$

This x is the total pounds of dry steam condensed. The total amount of steam and moisture which entered the barrel was w pounds. So the percentage of dry steam is

$$Q = \frac{x}{w} = \frac{W(t_2 - t_1)}{wl} - \frac{t - t_2}{}$$

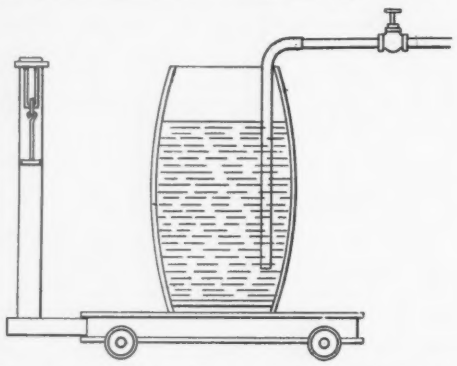
While the barrel calorimeter is by far the simplest and easiest to construct, it is also the most liable to error, and it requires great care to obtain fairly accurate results from its use. In a great many instances, however, the determinations by this calorimeter are sufficiently close for all practical purposes. When the most accurate tests are to be made and the moisture in the steam determined with the highest degree of perfection, it is necessary to use a calorimeter in which the errors liable to enter are reduced to a minimum. The separator calorimeter fulfills these conditions. It is illustrated in the second figure.

It consists of a main chamber B, to which is attached a water gauge A. Above this chamber B are several other pipe connections. One of these, F, admits the steam which is to be tested for moisture. It opens into E, which is continued downward into chamber B, as shown by the dotted lines. This pipe is perforated with a large number of holes about ⅛ inch in diameter. The steam, entering at F, is deflected into pipe E and escapes into chamber B through the small holes, in doing which

the moisture is removed, and falls to the bottom of chamber *B*. It is on this account that the name separating calorimeter has been applied to this instrument, since it acts upon the principle of the ordinary and familiar steam separator.

The steam, freed thus of its]moisture, passes up and out of the pipe *C*. In this pipe is placed a diaphragm *D*, in which is drilled a hole $\frac{1}{16}$ inch in diameter. At *G* is a pipe opening into the space connecting *F* and *E*, to which a steam gauge may be attached.

The operation of this style of calorimeter is as follows: The steam to be tested is admitted through the pipe *F*. As it escapes



from pipe *C* it should be led into a tank of cold water and condensed. In beginning a test, care must be taken to start all portions at one instant. First blow steam through the calorimeter to heat it. Then at a given signal turn the escaping steam into the condensing tank and note the level of the water in the gauge glass *A*.

This water level should be kept constant during the test, which can be done by drawing it off as fast as it collects through the cock *A*, this moister being kept and carefully weighed at the end of the test. When the steam has run for about half an hour, the test is stopped by shutting off the steam, drawing off the water in the gauge to its original level, and weighing the steam condensed in the tank. Then knowing the weight of steam *W* discharged from *C* and condensed; *w*, the weight of moisture drawn from chamber *B*; and the loss *R* due to radiation from the surface of the calorimeter; we have for the quality of the steam

$$Q = \frac{W + R}{W + w}$$

The radiation loss *R* is found by coupling another separator calorimeter, just like the one shown, to the pipe *C*. The steam leaving the first calorimeter and entering the second is dry steam, so that any moisture which collects in the latter, called *R* in our formula, is due to the condensing effect of the second instrument. And since the two are alike, it may be taken as the radiation loss of the first also.

It may be that in some cases it would be very inconvenient to condense the escaping steam. In such a case the amount of steam escaping may be calculated by taking the exact time during which steam flows, as well as the steam pressure by gauge at *G*. Then by Napier's formula for the flow of steam in a given time, through an orifice, we have

$$\text{Flow in pounds per second} = \frac{\text{pressure} \times \text{area}}{70}$$

the pressure being absolute and the area of the opening in the diaphragm being square inches. This will give the pounds per second, which, multiplied by the length of the test in seconds, must give the quality *W*. The same care in starting and stopping is necessary in this as in the previous case.

The above formulas as stated give the quality of the steam or the percentage of dry saturated steam contained in the current. To obtain the percentage of moisture it is necessary only to subtract the quality of the steam, expressed in per cent from 100 per cent.

Pittsburgh Engineers and the License Law.

There is probably no large city where the engineers are as near unanimously favorable to the passage of an engineer's license law as are the engineers of Pittsburg, which fact is no doubt largely due to the recent disastrous boiler explosions which have occurred there, thus bringing the members of the craft in that city and vicinity to a realization of the existing conditions.

One may travel from engine room to engine room there for days, and the common remark of all is, "we ought to have a license law."

But, while the engineers of Pittsburg are practically unanimous in their demand for the passage of a license law, this unanimity of opinion is not the only thing required to accomplish the desired result.

There are other and equally important questions to be settled. First, they should decide whether to expend their efforts in behalf of a city law only, or to adopt the broader view and endeavor to secure the passage of a law covering the whole State. Second, they should agree upon the general requirements to be embodied in any bill that may be presented, either to the State Legislature or to the City Council. Third, and most important of all, is the question of ways and means, and to this, as well as to the others, there is but one answer, namely, to organize; for by this means only can engineers hope to procure the passage of any desired legislation from any source.

Looking at the matter from an impartial view point, it would seem that the Pittsburg engineers should favor a law including the entire commonwealth, rather than a municipal law, and this, because of the peculiar physical conditions surrounding them.

A municipal law could not be made to include Allegheny, Homestead, or any of the many important nearby manufacturing towns, which are practically a part of the city, and which employ many engineers.

The matter of agreeing upon the general requirements of a proposed law is where considerable difficulty is likely to be experienced, for as it stands at present this is a question upon which the Pittsburg engineers differ greatly.

A few of those who are fortunate enough to hold the larger and more important positions usually favor a "graded" license, but each has a different idea as to the best method of grading, and it is right here that the greatest difficulty is likely to arise.

The majority of the engineers, however, seem to favor a uniform, one grade license for actual operating engineers, with a lower grade to cover such positions as watchmen left in charge of boilers, water tenders, hoisting engineers and possibly for stationary plants of less than 10-horse power or thereabouts.

This latter method appears to be the more sensible and most likely to receive consideration by either the City Councils or the Legislature, but if the Pittsburg engineers are wise they will simplify matters still more by adopting a "service" clause, giving a license without examination to any engineer who has been employed at the business, in the State, for a period of, say, five years just preceeding.

A clause of this nature will prove invaluable in overcoming the opposition of influential manufacturers who happen to have favorite old engineers in their employ whom they may fear to lose through their inability to successfully pass an examination.

Again, such a clause is not as bad as it at first seems, for after the law is in operation a few months and the first licenses are granted, it becomes a dead letter.

Many of the men who favor a graded license do so because they fondly imagine that their positions, rather than their knowledge, will insure them a certificate of the highest grade. If these men were familiar with the history of engineer's license laws, especially that in Massachusetts, where several grades of licenses are issued, they would doubtless fall over each other in an attempt to prevent the passage of a graded law instead of encouraging its adoption.

When the bill providing for the Massachusetts law was presented to the Legislature a number of Boston engineers, who were holding big jobs, insisted upon provision being made for several different grades, with the result that when the bill was finally passed and became operative, an overwhelming majority of these same "big fellows" received licenses below the first grade, many receiving the very lowest grade issued. Of course, they squealed like stuck pigs, but it was too late, and many of their positions are now filled by younger men, who formerly urged them to accept a bill providing for a uniform grade of license.

The single grade license law possesses an additional advantage in that it has a beneficial influence upon the examiner who has to decide who is and who is not entitled to a license. If he is working under a graded law and an applicant under examination does not satisfy him, he may be tempted to give him a low grade certificate as an easy way to get rid of him and still earn a fee for his office. The trouble in such a circumstance, and there would doubtless be many such, is that man still remains in the business as a sort of barnacle and a menace to the public. Whereas, with a single grade law, all licenses are first-class, and the examiner will use greater caution and will be more likely to rid the profession entirely of the incompetents, thus curtailing and restricting the supply with a consequent impetus to the demand as well as compensation, which, after all, is a very important consideration.

If the Pittsburg engineers hope to secure the passage of a license law at the next session of the legislature they must, without delay, settle the question of ways and means; for no law of this character can be gotten through the Pennsylvania Legislature without hard work and lots of it, and money, too, must be raised to defray the legitimate expenses of the workers, which are necessarily high.

To accomplish these things the engineers must be organized; every operating stationary engineer in Pittsburg and vicinity should join and support an organization which is endeavoring to improve the condition of his profession. And right here is where all such engineers should exercise their best judgment and make sure to join the particular organization best qualified to secure the passage of the desired law.

The American Order of Steam Engineers is the only organization that has ever made a successful effort in behalf of the engineers of any portion of this State; moreover, this organization is the best equipped, both in point of numbers and finances, to conduct an energetic campaign in behalf of a State license law.

It was the American Order of Steam Engineers that secured the passage through the State Legislature of the bill providing for the licensing of engineers in cities of the first class, which law is now operative in Philadelphia; and the fact that that bill was passed in spite of the opposition of numerous engineers and manufacturers, entitles the American Order of Steam Engineers to still greater credit than would be due under ordinary circumstances.

In Philadelphia the A. O. S. E. has a very large and growing membership, while in most of the more important towns of the State they have thriving councils, all of which are ready and eager to support any movement looking to the passage of a State license law.

But there are other reasons why the Pittsburg engineers should become members of the American Order. It is an order for engineers and engineers only, and each member must not only be an engineer, but must be a white American citizen, thus giving each member an assurance of security from contact with undesirable associates, which other organizations do not afford.

In addition, the American Order of Steam Engineers is chartered under the laws of the State of Pennsylvania and is a beneficial organization, operating under the most successful conditions, each subordinate council being enabled to pay generous benefits in case of the sickness or death of its members.

Items of Interest.

The Lakewood Hotel, Lakewood, N. J., is certainly a good place for firemen to be employed. "Garry" Estell and Antonio Manges, both of whom for sometime past have been engaged in the above mentioned capacity there, have fallen heir to small fortunes through the demise of rich relatives. Estell received a legacy of $35,000 through the death of an uncle, and Manges, through the passing away of an aunt, received $12,500. They both have resigned their positions in order to, as they put it, "give some one else a chance at a good thing."

Undoubtedly there will be no trouble experienced in filling the vacant places under the circumstances.

Ground was broken on December 20th for the World's Fair, which is to be held at St. Louis next year to commemorate the Louisiana Purchase. A prayer was offered by the Rev. Dr. Nichols, and speeches were made by Corwin Spencer and D. R. Francis, president of the Fair Company. After the ceremonies on the ground a largely attended meeting was held at the Coliseum, speeches being made, and Congressman Tawney reviewed the Louisiana Purchase and the benefits which accrued to the United States therefrom.

MODERATE SPEED ENGINES.—It is broadly claimed that moderate speed engines are much more economical than high speed engines under all conditions, and are as economical as slow speed engines under similar conditions; they are adapted to a much wider range of conditions than either high or low speed engines, and, all things considered, give the highest return on the investment. The results obtained during the past five or six years seem to justify these claims, and the increased attention shown by high speed and slow speed engine manufacturers to this field is a tacit recognition of its importance.—*Am. Elec.*

The development of the water power of the falls of the Susquehanna River, at York Haven, Pa., will be completed next fall. While not on so gigantic a scale as Niagara, yet it marks a very important step in power production. Some idea of its importance can be learned from the plans of the company, which for the preliminary installment are as follows:

A power house, 478 feet long, 50 feet wide, will contain 40 turbine water wheels of 600 horse power each. The plant was designed by George B. Burbank, formerly of the Niagara Falls Power Co. The company has a capitalization, stock and bonds, of $4,500,000, and expects to attract a great many industries upon its completion.

The Practical Engineer.

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Brother John H. Cunningham has been elected Chief Engineer of John E. Sweet Council of Syracuse, N. Y. His address is Hall of Language, Syracuse University. S. A. Steel, 311 Orange street, was re-elected as Corresponding Engineer.

Quite a number of supply men and steam specialists, salesmen from Philadelphia and other points, will attend the Pennsylvania Grand Council Convention at Allentown, Pa., on Tuesday, the 18th of March.

Headquarters for officers and delegates to the Pennsylvania Grand Council Convention at Allentown will be at the Grand Central Hotel, Hamilton street near Eighth.

Municipal Council, P. F. D. of Philadelphia, will hold their first quarterly meeting at Girard Hall, Girard Avenue above Sixth Street, on Monday evening, March 10th. All local members of the Order, who can make it convenient to do so, are respectfully invited to attend.

The Executive Board in charge of arrangements for entertaining the officers, delegates and visitors to the sixteenth annual convention of the American Order of Steam Engineers, which will be held at Reading, Pa., commencing May 12th next, announce that the convention will be held in Rajah Temple, on Franklin street near Sixth, instead of Deibert Hall, as previously stated. This change has been made in order to provide more commodious accommodations, and for the purpose of affording an opportunity to manufacturers of steam specialties and supplies, in which engineers are interested, to exhibit their products to the best possible advantage. Ample space will be provided for this purpose in the same building in which the regular sessions are held, and charged for at a moderate rate. Any one desiring information upon this point should address communications to the Executive Board, care of Board of Trade rooms, Reading, Pa.

Millville Council, No. 6.

The following newly elected officers of Millville Council, No. 6, of New Jersey, have been installed: Chief Engineer, DeLynn Friet; First Assistant, Wm. F. Pond; Senior Master Mechanic, David H. Hayes; Junior Master Mechanic, Joseph H. Hawkins; Recording and Corresponding Engineer, Lewis Dougherty, 604 Mulberry street; Financial Engineer, Joseph Messick; Treasurer, B. Frank Parks; Chaplain, J. W. Mathias; Sentinel, Walter Whitaker.

Kensington Council, No. 3.

On the 23d of January, Grand First Assistant Engineer Wm. J. Gifford installed the following newly elected officers of Kensington Council, No. 3: Chief Engineer, Wm. S. Stott; First Assistant, D. J. Ezrah; Recording Engineer, Wm. B. Roland; Financial Engineer, Edward C. Ricker; Treasurer, Chas. Cook; Corresponding Engineer, Charles Fournier, 3115 Richmond street; Senior Master Mechanic, John C. Anson; Junior Master Mechanic, Charles R. Chidister; Chaplain, Charles Cook; Inside Sentinel, Ernest Ritsert; Outside Sentinel, George Wheatcroff; Trustees, Charles Leng, Frank Mellor, Ernest Ritsert; Delegate to Grand Council, Edwin C. Ricker; Alternate, Charles Leng.

The Coming Pennsylvania Grand Council Convention.

The coming convention of the Grand Council of Pennsylvania, which will be held in Allentown on Tuesday, March 18th, will be the first State Convention ever held outside of the city of Philadelphia, and it is specially notable that more enthusiasm is being manifested over the prospects of the convention than of any previous one in recent years, which fact is ample justification for the change. It would not be surprising if many years shall have elapsed ere another Grand Council Convention comes to Philadelphia.

The prospects of a convention in Allentown seems to have put new life into the up-State members, and as one of them puts it, "makes us feel that we are on an equality with the Philadelphia members, instead of simply auxiliary bodies, as we often felt ourselves to be under the old method of holding all State Conventions in Philadelphia."

The members of Lehigh Council, No. 15, of Allentown, are making elaborate preparations for entertaining all officers, delegates, visitors, members and friends, and a lively time is promised. The feature of the occasion will be a banquet at the Grand Central Hotel on Tuesday evening following the session, and all who are familiar with the extreme hospitality and jovial sociability of the Allentown people, especially the members of Lehigh Council, will anticipate a pleasant evening.

The Grand Council will convene at the rooms of Lehigh Council, 639 Hamilton street, at 9 A. M. sharp Tuesday, therefore it will be necessary for most of the delegates to leave home on Monday evening in order to be present at roll call. Most of the

Philadelphia delegation will leave the Reading Terminal on the 6.00 P. M. express Monday evening. Those who cannot get away at that hour may go at 8.30, or on the 6.00 A. M. train Tuesday. All trains will be met at the depot by a special committee appointed for that purpose.

Educational Committee, A. O. S. E.

JOHN MARTIN, Secretary, 2655 East Clearfield St., Phila.

The following questions are intended to create discussion in councils of the American Order of Steam Engineers. Answers will not be required by the Committee but prizes will be awarded by the Committee for the best essays prepared by individual members upon any of the questions asked. The PRACTICAL ENGINEER will give cash prizes for the best essays prepared by engineers whether members of the A. O. S. E. or not

1. Explain the compression system. Why is it called a compression system? Name the different parts used in this system.

2. What is the difference between the atmospheric and submerged condenser?

3. Explain the difference between the direct expansion and brine system. Which system is mostly used?

4. How is the brine circulated in the brine system? Is the brine circulation independent of the ammonia? When and where do they come in contact? In ice making how is the brine tank arranged?

5. Suppose one field magnet coil of a four-pole motor was connected reverse and the armature wound as a four-circuit armature, what would happen to the motor if you tried to start it? What would it do if the armature was wound as a two-circuit armature?

6. What is the action of a compound wound motor operating machine tools that have heavy fly-wheels?

7. When it is not absolutely essential to have steam speed, which is the best motor to use, shunt or compound?

8. What effect would we get from operating two 220-volt series motors in series?

9. How many losses are there by using a booster in the power house to boost the current up to 50 volts higher than the generator voltage?

Please send answer to this last question to THE PRACTICAL ENGINEER.

Bridgeton Council.

Deputy Supreme Chief Engineer of New Jersey, Francis O. Garrison, installed the following officers of Bridgeton Council, No. 5, on Friday evening, Jan. 31st: Chief Engineer, Philip H. Young; First Assistant Engineer, H. H. Hummell; Senior Master Mechanic, D. R. Jones; Junior Master Mechanic, Frank R. Ayers; Corresponding Engineer, F. O. Garrison; Treasurer, C. C. Stremmy; Sentinel, Frank Clark; Chaplain, Frank Hannon; Trustee for three years, Lorenzo Sharp.

Clifford P. Williams Council.

On December 19th the newly elected officers of Clifford P. Williams Council, No. 2, Milwaukee, Wis., were publicly installed by Deputy Supreme Chief Joseph Harris, with an attendance of about seventy engineers. Brother Harris made a decided hit as an installing officer. Brother Jacob Casper rendered one of his "originals," entitled "Goatless Carriages." Brother Harris gave us "Pipe Fitting in Street Cars." Short addresses were also made by E. W. Powers, D. T. Richardson and others, after which we retired to the banquet hall, where an elegant spread awaited us. Altogether we had a most enjoyable time.

The officers installed are as follows: Chief Engineer, D. T. Richardson; First Assistant, E. W. Powers; Recording Engineer, Jacob Casper; Corresponding Engineer, James T. Harris, 1619 Claybourn street; Financial Engineer, Frank Troezel; Treasurer, J. W. Green: Senior Master Mechanic, M. Nelson; Junior Master Mechanic, Val Neumer; Chaplain, T. H. Jewell; Inside Sentinel, F. Podginski; Outside Sentinel, George Cartwright; Delegate to Svpreme Council. J. T. Harris.

Resolutions of Regret.

Editor of THE PRACTICAL ENGINEER:—It being already some time since the death of our brother Past Supreme Chief Engineer H. B. Underwood, the Clifford P. Williams Council, No. 2, A. O. S. E., are still desirous of having the resolutions which were adopted by them published in THE PRACTICAL ENGINEER. The delay in forwarding same was due to an error during the absence of the Recording Engineer.

RESOLUTIONS.

Clifford P. Williams Council, No. 2, A. O. S. E., deeply regrets the loss of their brother engineer H. B. Underwood, Past Supreme Chief of the A. O. S. E., and extends their sympathy to the Council of which he was a member, and also to his grief-stricken family.

D. T. RICHARDSON,
JACOB CASPER,
Committee.

Old Friends in New Clothes.

By A. EDWARD RHOADES.

Part V.

Hot Air Engines.—(Continued.)

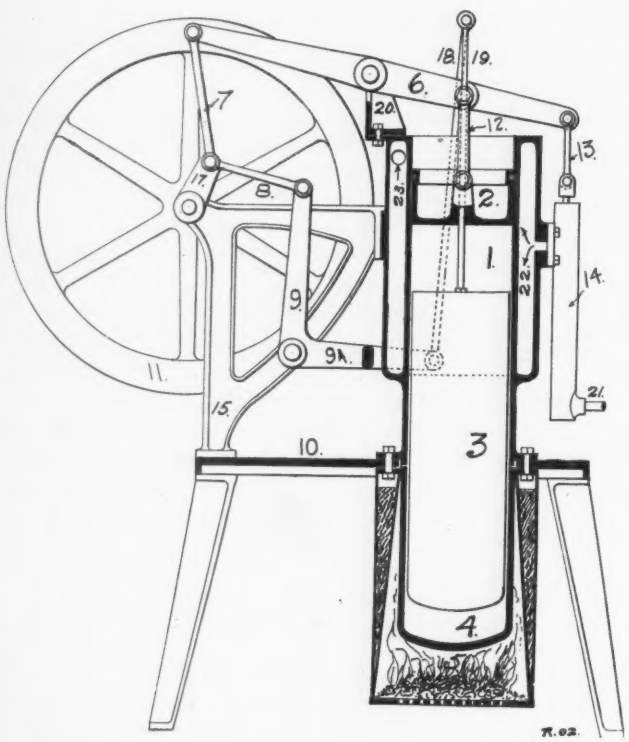
Externally heated air engines are now employed only for very small powers, from a fraction of 1 horse-power up to about 3 horse-power. Powerful engines of this type are impracticable on account of their relatively enormous bulk. Those that are now manufactured resemble the original Stirling engine (described last month) very closely in their action, and comprise essentially the same organs.

Figure 2 is a reproduction of the working drawings of an engine of this type as built by one of the largest firms of builders of this type of engines, and represents the engine as it has been built for years, with a record for economy and durability that is remarkable when compared with steam or electric power when used at the same places for the same purposes, namely: that of pumping water for domestic purposes.

The names of the several parts of figure 2 are: 1, cylinder; 2, air or working piston; 3, transfer piston; 4, heater; 5, furnace; 6, main beam; 7, connecting rod for main beam; 8, bell-crank link; 9, bell-crank; 10, bed plate; 11, fly-wheel; 12, working piston links; 13, pump connecting-rod; 14, pump; 15, crank-shaft bracket; 17, crank; 18, transfer piston connecting rods; 19, transfer piston rod; 20, bearing for main beam; 21, suction pipe—leads to well or water supply; 22, water jacket for refrigerator purposes; 23, opening to discharge pipe. It will be seen that the water pumped by this engine takes place of the coil in figure 1.

The engines just described are necessarily limited to comparatively low pressures, and hence must be very bulky when designed to develop considerable power. This limitation is an essential condition of their design, because the original pressure of the air, which is compressed and heated, is that of the atmos-

phere. If, however, the working air be confined in the machine, and originally compressed to a high pressure, this difficulty disappears. Thus, suppose it is found practicable to maintain a temperature in a given air-engine sufficient to double the original pressure of the air, then if the air were admitted at the pressure of the atmosphere the available pressure, after heating, would be about fifteen pounds per square inch. But if the supply of air were drawn from a receiver in which the pressure was sixty pounds per square inch, the effect of increasing the temperature to the same point as in the former case would be to double the original pressure, making it 120 pounds to the square inch. It seems strange that the majority of inventors should have ignored this significant principle, and that too in the face of the example afforded by one of the first air-engines ever constructed, and which seems from all accounts to have been more successful and economical than any of its successors.



It has been predicted by more than one prominent engineer that the steam engine will be superseded by the air-engine. In view of what has been already accomplished, the realization of this idea seems by no means impossible, while at the same time it must be confessed that a great deal has yet to be done before the air-engine can successfully compete with its present formidable rival. As the obstacles to the complete success of the air-engine consist chiefly of mechanical difficulties that must be overcome, the case does not seem absolutely hopeless. I had hoped to show with this article the very latest in air-engines, one that I designed for the builders, but their patent lawyer said "No," not until he can guarantee protection. However, I have the promise of the Wilmington Machine Company that the readers of the PRACTICAL ENGINEER shall see in their paper the first description of the modern and only mechanically constructed air-machine.

To be continued.

LETTERS FROM ENGINEERS

In order to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories and general engine-room experiences are especially solicited.

A Practical Home Made Economizer.

In making a study of the economizer, or feed-water heater, an illustrated description of which appeared in the "Letters from Engineers" columns in the February number of THE PRACTICAL ENGINEER, I would ask "A Reader" if he doesn't think the following method will eclipse that shown by him. In looking over Fig. 2 you will see that there is provision made to obtain the very best results from the heat in the flue which might otherwise

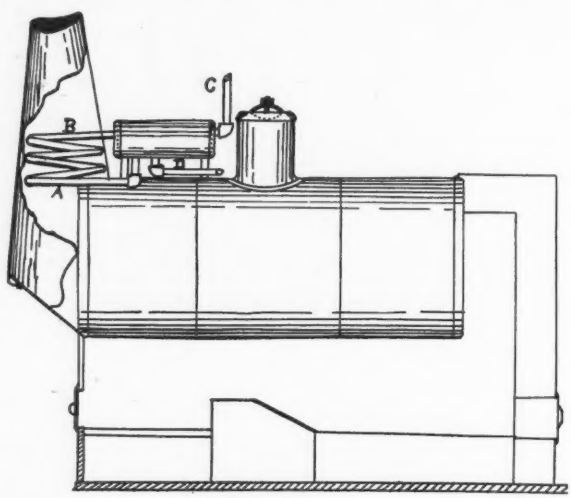


Fig. 2

be lost. The coil is so arranged as to use a continuous circulation through the tank and in that way obtain a good supply of hot water at all times at very little cost. *A* shows connection to tank of coil; *B* shows method of connecting the circulating end; *C* is the supply pipe from city main, or tank, and *D* shows the feed pipe to pump. It is preferable to make the coil of copper or brass, as iron will very quickly deteriorate if used in this way.

HARRY SLACK.

Feed Water Heating.

The feed-water coils in the stack of "Readers" boiler, page 20, February issue, recalls to mind a smilar coil placed in the stack for the first boilers on the steamer Republic., plying between Philadelphia and Cape May, and where it gave so much satisfation that Captain Brink was induced to make some experiments aboard the tugboat Rambler, recently burned on the Delaware river.

On the Rambler the feed-water pipe was introduced into the front end of the boiler (Scotch Marine type), underneath the grate bars, to the back end of the boiler into the combination chamber where it was formed into a coil to give more heating surface. This coil was connected with the inside of the boiler in the usual manner, the hot feed water entering from the rear end. The means adopted for forcing the feed water through the coil was, both pump and injector so arranged that they could be worked at the same time or independently. Captain Brink says that owing to the peculiar conditions under which these tests were made it was impossible to protect the feed-water pipes from the direct heat from the fire, consequently when no water was being forced into the boiler they became overheated to such an extent as to be absolutely dangerous, and the idea of heating the feed water by this method had to be abandoned in spite of all of the apparent advantages. Why the coil in the steamer Republic was discarded I have been unable to learn. Perhaps some reader of THE PRACTICAL ENGINEER, who is in close touch with our marine service, can tell us.—A. EDWARDS RHOADES.

Artificial Refrigeration.

Educational Committee of A. O. S. E.:

Dear Sir:—I will endeavor to write an essay on the questions asked by the Educational Committee of the A. O. S. E. in January, which are as follows:

1. What are the principal fluids used for refrigeration?
2. What is ammonia composed of, and how is it made?
3. Explain the meaning of anhydrous ammonia. What are the advantages of anhydrous ammonia over other fluids for ice making and refrigeration? At what degree of Fahrenheit does pure anhydrous ammonia boil?
4. What effect has anhydrous ammonia on metals such as steel, iron, brass and copper?
5. What systems of refrigeration are in general use?
6. Explain the difference between the absorption system and the compression system.
7. Name the different parts connected with the absorption system. What kind of ammonia is used in this system? Which type of condenser is used in this system? Explain the operation of the absorption system.

Ammonia is prepared on a large scale by heating together in a glass or iron retort calcium hydrate and ammonium sulphate or chloride. When pure anhydrous ammonia is required the gas must be passed over calcium oxide (or quicklime) to remove moisture, and collected over mercury. The word anhydrous means free from water. At the present time our supply is obtained by a similar process, in which coal is the material used. Bituminous coal yields on distillation about two per cent. of ammonia, which therefore occurs in the ammonical liquid formed during the manufacture of illuminating gas. In addition to free ammonia there are present in the ammonical gas liquid the carbonate sulphide, sulphate and throsulphate. The gas liquid is usually distilled with lime, by which the ammonia is liberated and collected in a suitable receiver with some water. This distillate is neutralized with hydrochloric or sulphuric acid, and the resulting ammonium chloride or sulphate purified and used for preparing other ammonium salts.

Properties.—Ammonia is a colorless gas of a pungent, suffocating odor and a caustic taste. It has a density of 8.5, being a little more than half as heavy as air. The gas is liquified by passing into a tube cooled to 40° by means of a mixture of ice and calcium chloride. It may also be liquified by subjecting it to a pressure of from six to seven atmospheres. At ordinary temperature this liquid is colorless and highly refractive, and may be solidified by cooling to 75°. At 38½° below zero ammonia boils, and in vaporizing absorbs latge quantities of heat. On account of this property it is used in ice machines and in several varieties of cooling apparatus; in breweries and cold storage houses.

The advantages of anhydrous ammonia over the other fluids for ice making and refrigeration are its great stability, its non-inflamability and non-explosiveness. Ammonia in itself is a slight lubricant, and has no effect whatever on iron, steel, brass and copper. It will eventually purge and scour the entire system clean to the metal surface, the loose foreign matter being caught in the separators and interceptors provided for the purpose.

There are three systems of refrigeration in general use, the brine system, the direct expansion system and the absorption system. The principal difference between the absorption system and the compression systems is that in one the compression is performed by the expansion caused by heat, while in the other it is produced by the action of a pump.

The different parts connected with the absorption system are:

1. Generator, a still with coils.
2. Analyzer, a drying chamber with baffle trays.
3. Exchanger, a heater with coils.
4. Ammonia condenser with drips.
5. Cooler for weak liquor with coils.
6. Absorber with coils.
7. Ammonia pump.
8. Receiver for ammonia.
9. Brine tank or congealer.

The ammonia that is nsed in the absorption system is largely reduced and mixed with water, so that it is 2.6 per cent. strong, called aqua-ammonia. The condenser generally used in the absorption system is vertical coil, with ammonia drip pipes at one end, and is placed in a round iron vertical tank.

Fraternally yours, HARRY W. SHERMAN,
707 Jackson street, Wilmington, Del.
Member of Delaware Council, No. 1, A. O. S. E.

How Dan Rice got his Electrical Knowledge.

There are two ways in which the steam engineer can get his practical electricity, one of which I will describe by giving the experience of our man Dan Rice. We have a 250 horse-power engine and three boilers which Dan has had charge of for six or seven years and keeps in first-class condition. Dan's trouble began when he put in a dynamo so we could furnish our own light. The dynamo was set up and the wiring and connections made by a man from whose firm we bought the machine. Dan did not want to appear green, so he did not ask many questions.

The man told Dan that if the commutators sparked to shift the brushes to and fro, and if that did not stop the sparking to apply some vaseline. As he did not say how often or how much, Dan decided that a dose every five minutes would be the best plan, so he piled on vaseline until the machine was sparking badly, and Dan was in a stew. A salesman came along with a compound and told Dan it was just what he needed to stop the sparking; the compound man told him to take some kerosene and waste and clean the commutator, which he proceeded to do, the sparks

setting the kerosene on fire and the waste was drawn under the brush. Dan, in his excitement, grabbed a pail of water and emptied it on the commutator. No compound sale was made, but the machine was sent off for repairs.

Dan found out that he did not know as much about electricity as he should, so he bought a book entitled "All About Electricity," he read this over but did not understand it. The machine came back and ran nicely until the wires got crossed, and before the fuse blew out a number of holes was eaten out of the commutator.

When he started up again he found that every time one of the holes came under a brush the brush would jump and spark; his new book told him "if the commutator was scored or rough to sandpaper it," but the holes were so deep that if he turned the commutator down until he got all the holes out he would not have much left.

That evening Dan called on the Engineer at the Electric Light Plant and made known his troubles; the engineer told him to clean out the holes and fill them with shellac, let it dry, then smooth it off with sandpaper. Before Dan left the engineer showed him one of their generators that the lightning had got at, burning out one coil and the connections between two others and the commutator, and how he had soldered the commutator segments of the burned-out coil to the next ones and made new connections out of wire for the other two, thereby keeping the machine in working order.

Dan began to be a frequent caller at the light plant and spent most of his time with the man at the switch-board; he worded his questions in such a way that one would think that he was familiar with his subject. When the plant was stopped and any mechanical work was going on, he would notice the way the electrician would do it and when he found how it was done he would suggest a better way to have done it.

In the course of time an addition was built to our factory, which called for 100 more lights. Things went on all right, but the lights were a little dim; the voltage stood at 108 when all the lights were on, instead of 115, as the machine was marked; volts, no load, 108; full load, 115; speed 800. Dan's book told him if he wanted to increase the voltage to either, speed up the armature or cut out more of the resistance in the shunt field, or both. But all the resistance was cut out and the speed indicator showed that the armature was running 810 R. P. M., so Dan found himself stumped again. The engineer at the light plant heard of Dan's new trouble, took him over to one of his generators and gave him a lecture on shunt, series and compound windings, something like this: "This small wire here starts from this terminal and is wound around this field pole a great many times, then it goes to the next one and is wound around it in the opposite direction; that is, to make one a north pole and one a south pole. After going around each pole in the same way it goes to the switch-board, then through the rheostat and back to this other terminal.

"Now suppose this is the only winding on the poles and that there are enough lights on to make the load enough so that the voltage will just hold up with all the resistance cut out. Now if 50 or 75 more lights are connected to the circuit, more load will be thrown on the machine; the voltage will drop a little and more current will flow around the fields, which will become weaker and the voltage will keep on going down until the lights will go out.

"Now you will notice this large wire that connects the poles close to the armature, this is called the series winding, because it is in series with the load. There are only a few turns of this wire around each pole, and, of course, they are wound in the same direction on each pole as the shunt winding. If the extra lights are cut in as before and the voltage started to go down, the shunt field would get weaker, but as soon as the lead increases the current will flow through the series winding and hold up the voltage.

"In most compound wound machines the builders put in more turns in the series winding than are needed to hold the voltage constant; this is called over-compounding.

"To hold the voltage nearly constant a shunt is put across the series winding so that only enough current will flow through the series winding to hold the voltage constant at all heads." Here Dan interrupted him to ask what a shunt was anyway. The engineer told him that the series shunt was just a by-pass;" it is thus regulated so that enough current flows through the series winding to keep up the voltage, the rest going through the shunt. You are not getting enough current through your series field to hold the voltage. What you want to do is to lengthen one shunt; this will increase its resistance and force more current around through the series field, but don't let them put any more lights on that machine; it is overloaded."

Should Nature or the Law Restrict Human Endurance?

EDITOR PRACTICAL ENGINEER:

Enclosed herewith please find a short item which I have just clipped from the Philadelphia Press:

Now, Mr. Editor, "I guess I went to sleep" is a good argument why an engineer should have a limit put upon the number of hours he should work. To my view there ought to be a law prohibiting an engineer from working more than twelve hours. I should very much like to read in THE PRACTICAL ENGINEER its opinion of "I guess I went to sleep." F. M.

PITTSBURG, Feb. 12.—"I guess I went to sleep on my engine after my train left Hayesville, and two minutes later we struck a stock train in which a drover was killed and another man was injured."

Such was the admission to the Coroner yesterday of William Jackson, engineer of Engine No. 695, which crashed into the caboose of a train between Haysville and Agnew, on the Pittsburg, Fort Wayne and Chicago Railroad. The engineer testified that he had been on duty thirteen hours and was tired out.

To the average person that may seem but a poor excuse for the taking of human lives and the wrecking of two trains, but it is just such a condition of affairs that causes more than one-half the accidents which occur daily; nor is this condition confined alone to railroad engineers. Take, for instance, a man in charge of a stationary plant, have him work all day and then find it necessary to work overtime, probably four hours. Now, look at the great strain upon a man under such a condition. At the best his position is productive of a languor which a man in the more active walks of life is not subjected to; especially is this true where the engine room may be in the basement or other enclosed places.

Again, let us take an engineer in charge of a fire engine. No matter how long a time his engine may be in continuous action he is expected to stay with it. There has been known times when engineers of this kind have stood by their engines for a period of 36 hours. One can imagine how conducive a condition of this sort is to the general safety of the bystander.

A man may be apparently awake and moving about, yet if his mind is clouded by lack of sleep he is little more than useless, for while in such a condition his actions are very little more than automatic, and he is often incapable of any unusual action.

Thus we can see the great danger the public is placed in by compelling men who have such responsibility to work beyond

their mental capacity, even though they should be physically able to stand the strain.

The writer knew of a case in which a man in charge of a locomotive sat in his seat and saw a train ahead of him knowing that he would run into it if he didn't shut off his engine and apply the brakes, yet he never moved a muscle. That the man did not lose his life was due to the fact that the train ahead pulled out, and the engineer, noticing the single engine running so close behind, knew that something was wrong and crowded on steam, so that when the crash came there was very little damage done.

The whole thing took place under the eyes of the division superintendent, in front of whose office the accident occurred. When questioned about the matter the man said he had been on duty 48 hours. This the superintendent disputed, but it was proven by his orders that while he had not been on the engine that long the engineer had been, because of the conditions of his orders, compelled to do without sleep for that period. In further explaining the matter he said he saw the train ahead and knew that he was going to hit it, yet he was powerless to make a move so completely were his senses benumbed. He said that if someone had touched him he would have been all right.

Undoubtedly this has been the condition of the mind and body of many who have been killed in accidents, and it is likely they could have done much to avert the accident if they could only have shaken off the terrible legarthy which creeps over one suffering from loss of sleep.

Only those who have experienced such conditions can really appreciate the terrible helplessness of a man in such a condition.

The above are only a few of the many reasons why State laws should be enacted of the most stringent character, making it obligatory upon employers of men who fill such positions to not only not ask their men to work above a prescribed limit, but to not permit them to do so.

If such laws were passed and enforced there is not the slightest doubt that both the employees and employers would benefit alike in the end as well as the general public.

While the railways may often be pushed for men, and likewise the manufacturer, to fill extra or unusual conditions, in the long run all will be benefitted by the decrease in accidents of all degrees if they are compelled to adopt, and live up to, a standard in the matter of human capacity.

This question has been discussed time and time again, and some States have even gone so far as to restrict such matters to a certain extent, but in no case has it ever received the proper and necessary energy to ensure its success from the engineers themselves, and until they will recognize the possibilities of their great strength as an organization and use their every honest endeavor to effect such organization, it will be useless for others to try to better their condition. It has been well said, "United we stand, divided we fall," and in no other vocation is there greater opportunity for successful unity than in the ranks of our steam engineers.

Invented a "Fog and Smoke Destroyer."

Fog and smoke-smothered cities will soon be of the past if the invention of an engineer of Dusseldorf, Germany, is all that the inventor claims for it. The device is what the inventor terms a "fog and smoke destroyer," and consists of a mechanical apparatus capable of consuming the particles that produce clouded air. It is claimed that the device has been so far perfected as to rob fogs of all their blinding effects. The inventor has brought his discovery to the notice of the British embassy at Berlin with a view of giving a practical demonstration in a typical London fog.

Questions and Answers.

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers with questions, he especially desires the readers in such cases to contribute any further information in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communications.

Editor of PRACTICAL ENGINEER—*Dear Sir:*—I fail to find anything definite in the various engineering books on the subject of steam cylinder lubrication. Can you give me the name of a book that will throw some light on this subject!

Yours, L. S. P.

Lancaster, Pa.

Write to E. F. Houghton & Co., 240 W. Somerset street, Philadelphia, for April, 1901, number of SUPPLIES, a journal published by that firm, in which is quite an exhaustive article on steam cylinder lubrication by Charles Everly Carpenter, the well-known expert on lubrication. We understand they will send this free to any of the readers of the PRACTICAL ENGINEER.

Editor PRACTICAL ENGINEER:—Please inform me through the columns of your paper what the effect of scale is upon boiler plates and tubes? How can scale be removed from the tubes? Is there any compound that will remove scale from an old boiler that has been in use for many years?

ALEXANDER ABRAHAM.

No more perplexing question presents itself to the engineer and steam user than the one inferred from the above question. Enormous losses of money, danger to life and property, etc., are involved in it.

In the first instance, there is the great loss of fuel resulting from incrustation. Careful experiment has proved an average loss of fuel from this source as follows:

1-16	inch of	scale	causes a loss of	13	per cent.
¼	"	"	"	38	"
½	"	"	"	60	"

That boiler explosions are caused very largely by heavy incrustations is no longer a doubtable question.

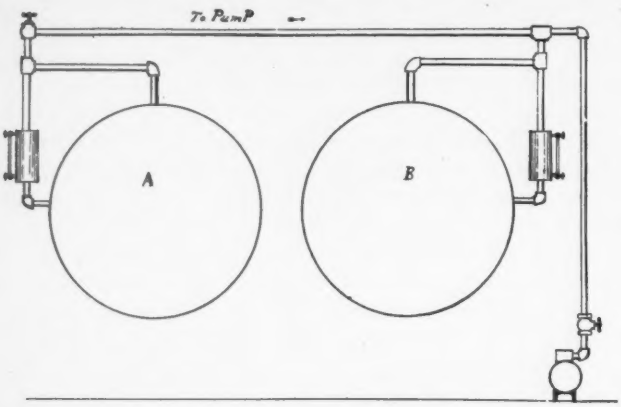
Nearly all foreign matter held in solution or suspension in water, on first becoming separated by boiling, rises to the surface in the form of what is commonly called scum. Here it comes in contact with heavier particles, which finally become of sufficient density to gradually fall to the bottom, where it becomes baked into a hard scale from the heat.

There are numerous compounds manufactured for the softening of scale matter so that it may be blown off or more easily removed by hand. A glance at the advertising columns of the PRACTICAL ENGINEEN will give adequate information concerning them.

The cause of explosion from incrustation is attributable to overheating the plates. This is superinduced by the coating of non-conductor (scale) existing between the water and the plates, thus causing them to become overheated, and while in such a condition they are incapable of withstanding the required pressure.

Editor of THE PRACTICAL ENGINEER :—

I send you enclosed a diagram of two boilers ; it will show you the position of the water columns, etc. You will notice that there is a steam pipe running from either column from which steam is taken to supply a small March oil pump. Suppose I raise steam in boiler A. Just as soon as I open A column and close B column the glass on A will break ; this same condition is



true if I reverse this rule and raise steam upon boiler B first. I have tried every conceivable way that I know to save my glasses, but to no purpose. I have tried closing both valves on the glass until the pressure is well developed, and then open them slowly in order to permit the glass to heat equally and not too quickly, but the results are the same. Can you suggest a remedy?

W L. BROUSSARD.

We would advise you to change your packing rings, they undoubtedly become hard and will not give with the expansion. In putting in the glasses be careful to allow plenty of room at the top; then tighten up the lower nut, making it water tight, but leave the upper one loose until it begins to leak steam, then gradually tighten under the rising temperature until it becomes steam tight.

There is a great difference between steam tight and water tight joints, the pressure having to be much greater in order to obtain a water tight joint than that of steam. If you follow this rule you will have plenty of expansion room at the top of the glass, which is usually effective in preventing breakage.

The steam connection to pump shown in your diagram is a very poor system, and possibly has a great deal to do with the glass breakage. As you use steam from the top of the column you are not only constantly varying the pressure on the glasses, but you are also decreasing the pressure to such an extent in the column that it is impossible for the glasses or cocks to show a true water level. We should advise you by all means to make your pump connection elsewhere.—EDITOR.

Editor of THE PRACTICAL ENGINEER :

I have often heard the remark that to return the flue over (in return tubulars) and to have the stack at the back of the boiler would effect a saving of twenty per cent. of the fuel. This does not appear reasonable to me, and I am also doubtful of the safety of such an arrangement. I would be glad to have the opinion of others on this subject.

E., Sudbury, Ont.

The subject of benefits obtained through the "overhead flue" in the matter of fuel saving and also the elements of danger existing through its use is a matter upon which there are many varying opinions. Some of the insurance companies do not advise its use, claiming there is danger of overheating the plates above the water line, but if the boiler is set properly the temperature at that part of the flue should not be high enough to endanger the plates, then again, it would only be a few hours until the shell would become coated with soot or dust to such an extent that all possible danger would be removed from the source of heat.

Regarding the saving effected in this manner, it is not likely to amount to very much. In the first place, the heat of the gases, as mentioned above, will be little more than that of the steam. Now, if you have a coating of dust or soot (which is an excellent non-conductor) over the shelf you practically eliminate any possible benefit from the heat passing over the top. Thus, you see, the matter of an overhead flue really becomes more a question o convenience in the manner of placing the chimney front or back, than that of economy in fuel or protection from danger.—EDITOR.

We would also like to have your views on the advantage of using superheated steam, and the best way to apply it.

W. A. EVANS.

To the latter question we refer you to the October and November issues of THE PRACTICAL ENGINEER, in which appeared an article upon the subject of superheated steam and which clearly delineates this subject.—EDITOR.

EDITOR PRACTICAL ENGINEER :

Will you please explain how steam, with the use of the injector, can lift water and force it into a boiler against its own pressure? I know that it does this, but I do not know just why, and take the liberty of asking you to explain through your columns.

A. T. M., St. Louis, Mo.

When H. J. Giffard, the inventor of the injector, tried to introduce the instrument, engineers laughed at him ; he was told to read the first rules of motion, and that he must be mad to suppose that steam from one part of the boiler would force its way back into another part of the same boiler ; he could not obtain authority from anyone to even try his device for nearly a year, and then he was only permitted to apply it to a locomotive more with the idea of proving to him that it would not work than with any hope that such a thing was possible.

Mr. Giffard's explanation of the system is about as follows: The action of the injector is similar to that of the blast pipe in a locomotive. The rush of steam in this case forms a partial vacuum into which air is forced by the atmospheric pressure of 15 pounds per square inch.

To explain his theory Giffard took a pressure of 100 pounds per square inch, and showed that a column of water $2\frac{3}{10}$ ft. high presses upon its base with a force of one pound, therefore 100 pounds pressure is equal to a pipe of water 230 feet high. Now water will rush from the bottom of such a pipe at a speed of 121.5 feet per second, that is equal to a speed of no less than 83 miles an hour.

Let it be clearly understood that a boiler having a pressure of 100 pounds per square inch is just balanced by a jet of water flowing at 83 miles an hour ; it then becomes certain that to overcome the steam in the boiler it is necessary to increase the speed of the water to 83 miles per hour.

It is a well known fact that the steam chest of a locomotive is actually under greater pressure than the boiler ; this is due to the momentum with which the steam flows through the pipes.

In the same manner the velocity of the steam through the injector is so great that it gains such a momentum that it not only has force enough itself to enter the boiler, but also it carries the water with it. Under favorable circumstances it is even possible to force it into a boiler having a higher pressure.

The Parker Exhaust Head.

A well-known professor of mechanics has said that in all power plant installations there are many necessary evils existing, and he instanced among other things elbows, in exhaust pipes, exhaust heads, etc., the theme of his discourse being "Elimination of Friction." Among other things he cited was the fact that seven elbows in a smoke pipe practically negatives the force of natural draught. This feature is true to a great extent in exhaust, and, in fact, in all piping the insertion of ells or bends adds its pro rata of friction, hence the best piping job is the one having the the least number of bends in its construction. Presuming that the above conditions are correct, it then devolves upon the manufacturer of exhaust heads to so deflect the steam with the least possible friction to obtain the maximum results.

Interior View.

Every exhaust head must more or less deflect the steam from a straight line to separate the heavier particles of water and oil (its function), and to that extent adds an element of friction to the egress of the exhaust steam. It, therefore, follows that the head presenting the least friction is the head that will give the best results.

Reference to the "Parker" Exhaust Head shows a curved baffle plate with a radius four times greater than the opening of exhaust pipe. The steam, striking against this plate at an acute angle, is gently deflected with the least possible friction, immediately expanding into the full area of the exhaust head and escaping through an opening at the top 30 per cent. larger in area than the exhaust pipe. This free interior expansion and large egress has given the "Parker" its reputation of being the best noise muffler made. It has been adopted by many country town electric lighting plants for the reason that after nine o'clock nearly every one is asleep. It has also been successfully used on gas engines. It will positively separate all water and oil from the steam and returns then through a drip at the bottom, thus keeping the roof dry and clean.

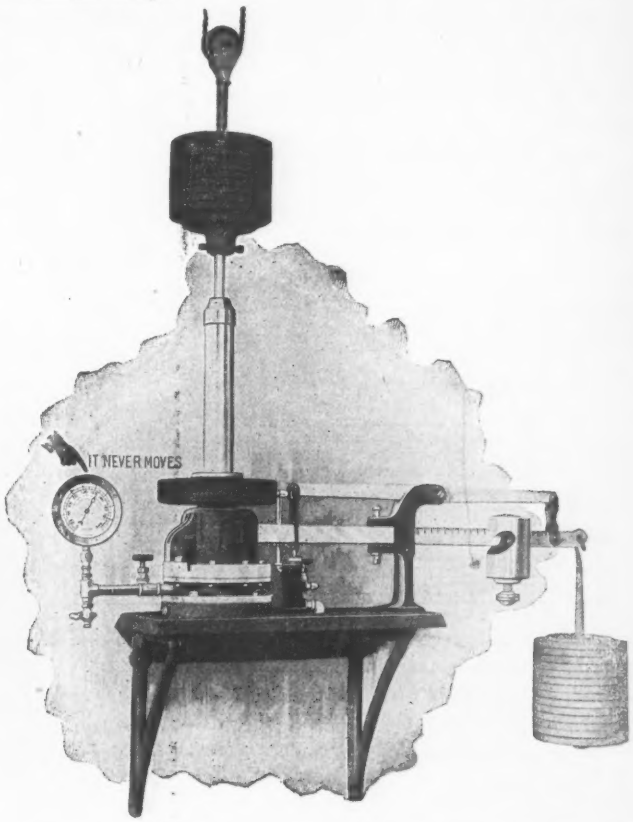
Exterior View.

The makers will be pleased to place one or more of their exhaust heads on a free trial test of 30 days to demonstrate its true worth to anyone interested. A letter to their Philadelphia office will receive prompt attention. Address T. T. Birchfield Company, 619 Arch Street, Philadelphia, Pa.

An Improvement in the Construcion of Damper Regulators.

Probably no other boiler-room appliance has more claim upon the steam user in the matter of economy than the damper regulator. It has a direct control over the consumption of fuel, and for that reason the results obtained appeal to the consumer. This interest is shared by the fireman, as the results obtained by mechanical control of the draft is one of the greatest kind of labor savers. Indeed there are so many points of merit connected with the use of the damper regulator that the question before the consumer's mind has become that of "What kind shall I buy?" and not "Do I need such a thing?"

This great demand for such an appliance has been met by devices of numerous kinds of more or less merit. The Wilkinson Manufacturing Company, Bridgeport, Pa., have placed upon the market one of the most complete, and withal efficient, appliances of this kind which has yet been exploited. The simplicity of construction, the method of obtaining the most powerful lifts through their manner of compound leverage, the very compact space required, and their method of constructing their diaphragm valve, places the Wilkinson Damper Regulator very much to the front, and it will repay anyone interested in such matters to give it a careful study.



The accompanying illustration shows the Wilkinson Regulator complete, and, as will be seen by examining the same, the construction is of the most compact type. Steam at boiler pressure is admitted to the base of the diaphragm; this diaphragm is so arranged as to raise the lever, which is graduated and weighted so that it can be set to raise at any pressure desired. This lever is then so multiplied that with a raise of one-eighth inch in the diaphragm it will immediately open full the floating hydraulic valve which in turn raises the hydraulic piston, to which is attached the damper weights, thus closing the damper with the increase of pressure above the set of the lever. The damper will then remain closed until the decrease in pressure permits the diaphragm to drop, which action effects an exhaust in the main hydraulic cylinder, thus permitting the piston and weights to again descend, and opening the damper.

So sensitive is this action that the variation of less than one-quarter of a pound in the boiler pressure will at all times either open or close the damper at once.

Another feature connected with this device is that where it is desirable to use forced draft of any kind the regulator can be

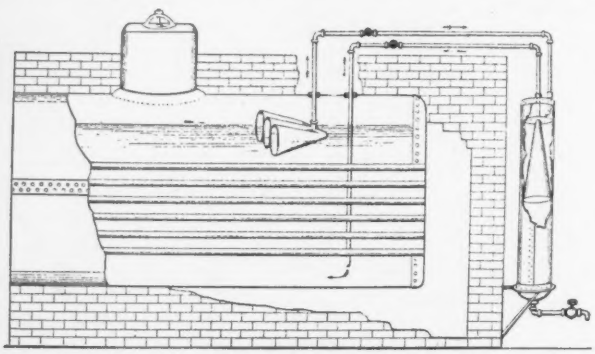
connected with and made to operate it in conjunction with the damper regulation, and in this way making your damper regulation absolutely automatic, no matter what the conditions are.

A further description and an effective trial test of the machine can be obtained by writing the manufacturers at the above address.

An Effective Mud and Scale Remover.

The elimination of scale or mud from a boiler is a feature that causes more work and worry to the engineer, and more continuous expense to the boiler owner than almost any other portion of the entire plant despite the multiplicity of devices and compounds used for the removal and prevention of such matter. It is a well known fact that 1.16 inch of scale causes a loss of 13 per cent. in fuel, while ¼ inch will cause a loss of 38 per cent. This is only one of the many great disadvantages of impurities in feed water.

It must be remembered that dry steam, as it is used from the boiler, is chemically pure no matter what the water may have contained before evaporation took place; hence in a battery of boilers burning, say 20 tons of coal per day and evaporating 10



pounds of water to the pound of coal, there is a body of water going through them every day of 200 tons; thus one can readily realize how very great is the problem of keeping the boiler free from scale or mud when we consider the amount of such matter that may be contained in every glass full of water. In considering the point of scale prevention it is well to note the fact that all foreign matter in water separates in the boiler on the surface, each globule, as it bursts into steam, leaving its atom of matter behind there. This action continues until the surface is covered with a thick film, or skin, which is finally productive of the condition known as "foaming."

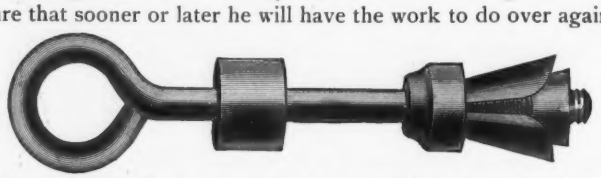
Taking advantage of the above well-known conditions, the Just Manufacturing Company, 207 Odd Fellows' Temple, Philadelphia, Pa., have placed upon the market the Just Automatic Water Purifier for Steam Boilers. A careful study of the accompanying illustration will show the manner of construction of the machine which accomplishes a continuous and automatic skimming of the surface, depositing the surface water into a cooling chamber from which the dirt matter is precipitated by change of temperature, the clear water being then returned to the boiler automatically, thus preventing all waste. The method of operation is extremely simple and will at once appear very feasible to the observer. First, there is a set of copper skimmers attached to the inside of the boiler on the water line of such size as to allow a 10-inch variation. These are connected to a 12-inch cooling tank where the reduction in pressure from condensation causes the constant "sucking" off through the "skimmers" of the surface scum. This matter, upon striking the cooler tank, immediately precipitates. Meanwhile the water rises in the tank up to the inverted funnel (which is placed therein to prevent agitation by the inflow) until it reaches the return pipe, whence it is returned to the boiler in the manner shown in the cut.

The return is effected by the well-known action of the "steam loop," the pipe being arranged with a trap to throw all condensation towards the boiler. The return pipe, or the drop-leg, in this way becomes filled with water to such a height as to overcome the reduction in pressure in the tank by its superior weight, thus making a complete siphon, and insuring a constant return as long as the boiler is under steam. The company have such confidence in the machine that they will place one or more of them with any one interested for an absolutely free trial, guaranteeing to not only remove the new scale forming matter, but will also agree to remove the old scale as well. This is readily affected by the expansion and contraction of the boiler cracking the incrustation, which finally falls through lack of new matter to stick it fast.

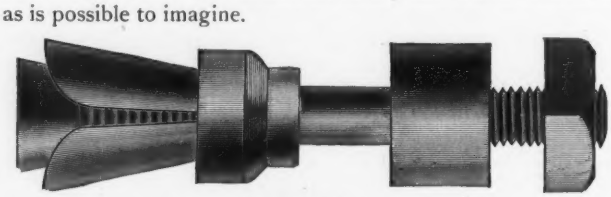
A number of the largest concerns in the country are using this device at the present time with the best of results, it being especially desirable in ice making or dye houses. The American Ice Company have adopted it upon all their plants in the East, as have also a number of other manufacturers. A postal to the above address will obtain further particulars upon this matter.

The Positive Expansion Bolt.

No one knows better than the engineer the evils attendant upon making a substantial fastening in a brick or stone wall or boiler setting masonry. How many times, when seemingly he has a guy pin set tightly in cement will the pin pull loose, and in that way undoing hours of good, hard work? Or maybe it is necessary to make a fastening in the side of a boiler setting; it cannot be put in safely with sulphur, for the heat will likely soften the setting; and if he uses a spike, even while driving it he feels sure that sooner or later he will have the work to do over again.



There has long existed a want for a positive expansion bolt of some kind to meet this condition. In realization of this Messrs. D. C. Seamans and Company, 1638 Hutchinson street, Philadelphia, Pa., have placed upon the market the type of expansion bolt shown in the accompanying illustration. This device is not only absolutely sure in its action, but it is of such simple construction that it can be inserted as readily and with as little trouble as is possible to imagine.



The method of expansion used is by direct pull from the base of the bolt, thus insuring a bearing which, to dislodge, would mean the tearing away of the material of the side wall throughout the bolt's entire length, a thing to all purposes impossible. Another advantage is that the company manufacture a multiplicity of sizes, and in that way can meet all possible requirements for such an article. They can also be purchased in quantities, ranging from a single one up, thus placing them within the easy reach of all. Further particulars can be had and free samples by addressing an inquiry to the above mentioned address.

Larkin's Metallic Packing.

The difference between the indicated horse-power and the effective horse-power of an engine depends largely upon the amount of power absorbed in friction. In some cases, where pistons are worn and pitted and a poor quality of packing used, this loss may amount to thirty or forty per cent.. Thus it can be readily seen that therein lies one of the greatest possible opportunities for obtaining a great economy in power.

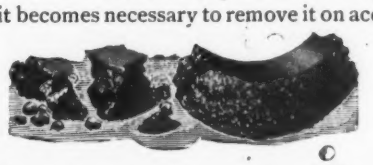
This is a feature which no live twentieth century engineer can afford to overlook. The days of hemp, or other like packings, has long since passed, having been displaced almost wholly with the more modern and economical metallic packing.

The Larkin Metallic Packing Company, Pittsburg, Pa., are manufacturers of a new and apparently very excellent type of metallic packing which will appeal to many of our readers.

This packing is a peculiar composition of high-grade metal and graphite formed into small irregular-shaped grains, which, for convenient handling, are placed in thin cotton tubes, from

which rings of any desired size may be cut, as shown in Fig. No. 1., and placed in position in the stuffing box in the same manner and with as little trouble as ordinary fibrous packing, after which it may be followed up until it forms a full, smooth bearing on the rod as represented in Fig. 2, which shows a section of the packing after it has been in use and the web or tubing has worn off.

The grains do not become so solid that they cannot be readily removed, as the contact between the particles is easily broken, and if at any time it becomes necessary to remove it on account of over-



hauling machinery, the packing can be readily taken out in pieces, as shown in Fig. 3, and crumbled back into its original shape, where it can be again placed in cotton tubing and used over again.

The makers name a number of large plants where this packing has been in use for the past three years without showing any appreciable wear. Its lubricating qualities are a part of the composition, thus making it permanently self-lubricating.

Among the many valuable features claimed by the makers for this packing is that it is always good and can be used over and over again, as its quality never depreciates.

For handsome illustrated circular, prices, etc., write the Larkin Metallic Packing Co., 23 Imperial Power Building, Pittsburg, Pa.

The Lee Injector.

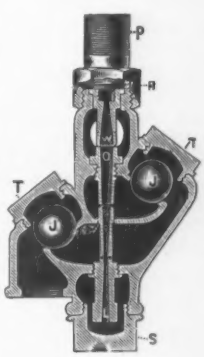
The Lee Injector Manufacturing Company, of Detroit, Mich., have issued a new catalogue, illustrating the Lee Ball Valve Automatic Injector and other goods manufactured by them.

On examination of the mechanical construction of the devices manufactured by this company, there is every proof that the ingenuity of man is never idle, but ever advancing.

In the Lee Ball Valve Automatic Injector there are some striking and novel features of mechanical ingenuity. The inventor has entirely obliterated the moving or sliding ring or collar on the delivery tube which is characteristic of other automatic injectors. This ring or tube at times has been a great source of annoyance, not only to the manufacturers themselves, but to the users as well, from its natural liability to lime and stick, causing the injector to work badly or not at all, and the removing of it is a long advancement toward perfection.

They have incorporated a new and novel idea in their overflow valves, which are nothing more or less than two spherical, hard brass balls, which are practically indestructible, and by which the user gets rid of the annoyance of the valves liming or wearing and causing trouble.

From the natural construction of the chambers in which the overflow valves are located, standing at an angle of 40,° they naturally go to their seat by gravity, and are held firmly there by the vacuum that is formed in the injector, which makes it work very strong automatically, this point within itself recommends the injector to all users wherein automatic qualities are required.



The manufacturers claim that their injector will work from 20 pounds steam pressure low to 160 pounds or better high, will lift promptly 20 feet from 60 to 100 pounds steam pressure, handle very warm water, and has the advantage of a 50 per cent. throttle in its supply to the boiler, and on such throttle does its work promptly. The obliteration of all complications, and the broad range of work that the injector is capable of doing, insures to the users an instrument worthy of consideration.

Their Ball Check Valve is the latest production in its line, and is a thorough success.

The company is composed of men with broad and extensive acquaintance in the manufacture and marketing of goods of this character. Write them for their latest catalogue, also their Treatise on Injectors, compiled by Mr. William O. Lee, their President and Manager.

Lloyd's Register inspects marine boilers when new, again at four years, at six years, and then annually. They are, however, supposed to be inspected every three months by the chief engineer of the vessel they are in, and also by the superintending engineer. In this country marine boilers have to be inspected every year by the Steamboat Inspection service, and are in addition constantly inspected by the engineers of the ship. The boilers of vessels on six-day runs or four-day runs are inspected on every trip, particularly where corrugated furnaces are in use.

Trade Notes.

T. T. Burchfield Co., 619 Arch Street, Philadelphia, have installed a number of plants of late, among which was a 9x10 Watertown Engine direct, connected to a C. & C. generator, installed in the new match factory at 25th and Wharton Streets; a 10x10 Watertown Engine, direct connected to a Deil generator, for T. H. Vanneman & Co, 525 Market Street, and also a 14x14 in the Brutnall Building, Ninth and Spruce Streets.

If you are interested in the matter of economical lubrication, the Philadelphia Grease Manufacturing Co., 147 North Third Street, Philadelphia., will send you a sample can of Philadelphia Grease and a brass cup free of charge. Mention this paper.

A sample can of Keystone Grease and a Keystone cup will be sent free to any engineer or steam user for trial. This company is one of the few concerns that has ever made a success of their business by sending out samples, which fact proves the unusual merits of their goods. Address, The Keystone Lubricating Co., 20th and Allegeheny Avenue, Philadelphia, Pa.

A Leakless Gauge Cock and a Quick Closing Water Gauge are two things that every experienced engineer can appreciate. If you have ever felt the need of these you know something of their value. If you have not at some time felt the need of them, well, you haven't been an engineer very long. Or perhaps you have made up your mind that such things don't exist; but they do. Paul B. Huyette, 1245 Betz Building, Philadelphia, makes them, and they are worth looking into. Write him for descriptive circular.

Economy in modern steam plants demands high grade packings, especially for the piston rods and valve stems. The Walker Metallic Packing, manufactured by Thos. Walker & Sons, 4619 Tacony St., Frankford, Philadelphia, is one of the oldest and most economical packings. Over a hundred thousand of these packings are now in use, the Carnegie Company having upwards of a thousand of them. A descriptive catalogue will be sent for the asking.

Gratifying Increase in Filtering Trade. The Liberty Manufacturing Company, Pittsburgh, report heavy sales for the Famous Oil Filter and Refiner. This they claim is owing to the fact that their filter sells for less money than any other of the same size, weight, filtering and storage capacity, and because it is sent on approval, or to be used in competition with any other make, with the understanding that the customer keeps whichever best meets his requirements.

Did you ever know that you can put one of the ordinary kind of common cheap separators on your main steam pipe, let the steam pass through a direct separator, and that the latter will take out the most water? Well, you can. It's been done often and can be done again. That's the difference between the right thing and the wrong. If you have any doubts about it, try them yourself. The Direct Separator Co., 200 Marcellus St., Syracuse, N. Y., will give you any further information that you desire. Their catalogue is valuable to any one interested in this subject.

Forty per cent. saved is what the Pilley Packing and Flue Brush Manufacturing Company, 308 North Main Street, St. Louis, Mo., claim for Pilley's Expansion Wedge Packing, which they say is the only packing having both a perfect expansion and a practical wedge. A special feature in connection with this packing is that the makers cut it into rings to fit the rod.

This is a point that will commend itself to engineers. This company also manufactures a superior line of steel wire flue brushes. Send for their catalogue.

Pittsburg has produced lots of good things, but it is doubtful if any of them have had a larger sale than the White Star Oil Filter, which is manufactured by the Pittsburg Gauge and Supply Co., 308 Water Street. The company have issued a book describing their filter in a most comprehensive manner. The illustrations alone make it worth having. Send for a copy and look it over for yourself.

A handsome Calendar, embossed in aluminum and bronze, has been issued by John A. Robeling's Sons Co., Trenton, N. J. Its leading feature is embossed reproductions of numerous medals received by the company from every quarter of the globe. A copy of the calendar will be sent upon request.

The Barr Pumping Engine Co., Germantown Junction, Philadelphia, always have a supply of catalogues, photographs and blue prints, which they will be pleased to forward to any one contemplating the purchase of a steam pump for any kind of service. Their down town office in Philadelphia is at 55 North Seventh Street, and is in charge of Al. Burns, who is well known to all local engineers.

Large Sales of Turbine Boiler Tube Cleaners. The Liberty Manufacturing Company, Pittsburg, report a wonderful increase in recent sales. In addition to their regular trade one firm has ordered 42 cleaners; another 100; another 180, and one company has just placed an order with them for 500 cleaners to be used during the current year—no doubt the largest order ever placed for cleaners of any kind for water tube boilers, and probably more than are sold in a single year of all other types combined.

CLIFFORD'S CELEBRATED RING PACKING

For Steam Engines, Ice Machines and Brine Pumps
We guarantee 50 per cent less friction than any other packing
TRIAL ORDER FREE
If you will send us the diameter of rod and stuffing box we shall be glad to send you a trial order free of charge
R. F. CLIFFORD & CO., 15 Marshall St., Boston, Mass.

REDUCED OIL BILLS.

Our Cross Oil Filters are guaranteed to reduce lubricating oil bills at least 50%. The standard for 11 years. Used in 28 different countries, adopted by 8 governments. Catalogs, list of users, testimonials, sent upon request. All Filters sent on approval.

Manufactured by
The Burt Mfg. Co., Akron, Ohio, U. S. A.
Largest Mfrs. of Oil Filters in the World
Cross Oil Filters carried in stock by the **Fairbanks Co.,**
Sole Agents for Philadelphia

THE POSITIVE EXPANSION BOLT

Special Discount to Jobbers. Write for Prices

Manufactured by D. C. SEAMAN & CO.
1638 Hutchinson St., Philadelphia, Pa.
For sale by Neal & Brinke, 18 Warren St., New York; Somers, Fitths & Todd Co., 323 Water St., Pittsburgh, Pa.

IF ENGINEERS will send $1.00 to the address below they will receive two blue prints, with tables and instructions, showing how to set valves and eccentrics on Corliss engines, simple and compound, with one and two eccentrics. JOHN T. LINDSTROM, 440 Liberty Street, Allentown, Pa.

DO YOU KNOW

That we manufacture chemical water purifiers that are guaranteed to prevent and remove incrustation in steam boilers, no matter what its composition may be.

CHEMICAL PURIFIERS

that do this without injury to the boiler, its fittings or connections;

CHEMICAL PURIFIERS

that can be used with perfect safety in Breweries, Ice Plants, Dye Works and all places where the water of condensation is used for any purpose.

Write for terms, reports, circulars, etc. We interest you and pay liberal commission. Agents wanted everywhere.

THE PEERLESS SPECIALTY CO.
1720 N. 5th St. and 1711 N. Randolph St.
Philadelphia, Pa.

The Catalogue of H. B. Underwood and Co., 1025 Hamilton Street, Philadelphia, is a handy little book for the pocket. containing not only their line of valve seat facing tools, boring bars and special machines for facilitating engine repairs, etc., but much useful data besides. They will send a copy to any reader mentioning this paper. Mr. D. W. Pedrick, who is an acknowledged leader in special tool designing and a thorough all-round mechanic, is now in active charge of these well-known shops.

Self-made men are nowhere so numerous as in this country. This fact should set many young men of to-day thinking. These self-made men rose from the ranks, many of them not having anything like the educational advantages that are now available. The trouble with many young men is that they are satisfied to work from day to day for very small wages and make no effort to advance. Happily, however, among our mechanics and artisans there are a few young fellows who are ambitious to push ahead. They mean to make their mark in the world. To a few such ambitious young men the Trustees of the American School of Correspondence, Boston, Mass., state that they are able to offer each year free scholarships in the engineering courses. The scholarships for this year are now availoble and applications will be considered in the order received. Write them for particulars, mentioning this paper.

The United States Metallic Packing Co., 427 North Thirteenth Street, Philadelphia, Pa., have published an unusually handsome catalogue describing and illustrating their large line of metallic packings for stationary and marine engines, a copy of which they will send free to any of our readers. This company has the largest metallic packing plant in the world, with a capacity of 14,000 packings a year. Their packings are in service on a majority of the locomotives now in use in the country and are giving universal satisfaction. The packings used on the engines of the royal German yacht Hohenzollern were made by this company.

Two Great Improvements in Edison's Phonographs and Standard Records are shown by Thwaites & Horner, 1215 Filbert Street, Philadelphia. The first consists of new high speed, hard wax moulded standard records, which are made of an entirely new composition much harder than the ordinary wax record.

The second is the new Edison Reproducer, which is described in a neat circular, which will be mailed to anyone interested. The records are much cheaper than the old wax records and the reproducers are such well constructed bits of mechanism they will appeal to engineers interested in talking machines.

A neat little catalogue is issued by John M. Watts' Sons, 123 South Second Street, Philadelphia, desbribing their various brands of packings, including Dirigo, Keystone, Wedge and Watts' Best Oil Proof Sheet Packing Also their Excelsior Lubricant and Nonpariel Belt Dressing. A copy may be had for the asking.

The Cling-Surface Manufacturing Co. have remembered their friends in the A. O. S. E. by printing them a calendar for the lodge rooms. They heve a few copies left and will gladly furnish one to any engineer asking for it.

WORKING OVERTIME

An hour a day will increase your wages a few dollars a week—**while the work lasts.** The same time spent studying at home has enabled our students in a few months to add **$25 to $50 a month to their wages—a permanent benefit.**

C. M. YATES, Oswosso, Mich., says:
"Since I entered the School I have had my salary increased from $60 per month to $100, as chief electrician and engineer of the Owosso & Corona Electric Co., and I now do all my own rewinding and repairing of the electrical machinery, which before I had to send to some shop."

The School is chartered under the educational laws of Massachusetts, and students are taught by graduates of Boston's noted engineering schools. A few

FREE SCHOLARSHIPS

IN

Mechanical Electrical **ENGINEERING** Steam Textile

Heating, Ventilation and Plumbing—including Mechanical Drawing

will be awarded to ambitious young men. Application should be made immediately, as the number is limited. Tuition is absolutely free, the only expense being the actual cost of instruction papers and postage.

Further information and large illustrated Hand-Book describing courses, methods, regular terms will be sent on request to any reader of "The Practical Engineer."

American School of Correspondence
(Chartered by the Commonwealth of Massachusetts)
BOSTON, MASS., U. S. A.

TWO FRIENDS

An engineer is a friend of **CLING-SURFACE.** It stops slipping of his belts so they can run easy under full load

It increases their output.
The ease from initial tension prevents hot bearings.
Taking up labor is much less frequent.
It preserves them, without making them sticky.
The worry and work of belts is off your mind.
You can know that they won't go back on you when you need them most.
Try it yourself.
Order and test.
Pay only if O. K.
Start now.

CLING-SURFACE MFG. CO.
185-141 Virginia Street, Buffalo, New York

Philadelphia, The Bourse.
New York, 34-41 Cortlandt Street.

SOMETHING

YOU SHOULD READ

GRAPHITE FOR VALVES AND CYLNDERS

is the title of a little pamphlet that tells of the experience of engineers who have used graphite for better lubrication.

SUPPOSE YOU SEND FOR ONE?

NO CHARGE

JOSEPH DIXON CRUCIBLE CO.

JERSEY CITY, N. J., U. S. A.

SALESROOMS AT
68 Reade St., New York City
1020 Arch St., Philadelphia
304 Market St., San Francisco, Cal.
London Office: 26 Victoria St., Westminster

Ever Think How Much

of all the heat put into steam in order to get power out of an engine is wasted—thrown to the four winds?

May be 5 per cent of the heat (and seldom is this exceeded) is converted into power by a non-condensing engine, and only something over 15 per cent in the very best of the condensing engines. Just think of the stream of dollars that is constantly passing through an exhaust main because so little of the heat is used! If you do realize it you will make every effort to utilize some portion of your exhaust through a good feed-water heater.

With a COCHRANE HEATER you can make all the saving there is to be made, whether it is only in heating and purifying the feed-water, whether heating and purifying the feed-water and heating water for dye-house or other manufacturing purposes, or whether in heating and purifying the feed-water and providing a heating or drying system with exhaust steam as well.

Write for Catalogue "16—H."

HARRISON SAFETY BOILER WORKS

3144 N. 17th St. Phila., Pa.

American Order of Steam Engineers.

ORGANIZED APRIL 27, 1886.

An Order of Engineesr for Engineers and Engineers only.

DECLARATIONS OF PRINCIPLES

Believing that ability will bring its full value in this country, this Order shall at no time take part in strikes, nor in any way interfere between employer and employees. Recognizing their identity of interests, it shall take no part in any project or enterprise that shall interfere with perfect harmony between them; neither shall it be used for political or religious purposes.

These principles shall not be amended or repealed except by unanimous vote of the Order.

Any member who shall be guilty of violating the principles of the Order shall be expelled.

OBJECTS.

First.—To promote a more thorough knowledge in its members of theoretical and practical steam engineering.

Second.—To assist members to obtain employment.

Third.—To help the sick, injured and distressed and bury the dead.

Fourth.—To establish a Widows' and Orphans' Fund.

Fifth.—To help members who shall become incapacitated from following the profession to obtain employment suited to their affliction.

Sixth.—To do our utmost to extend the license law throughout the United States.

Seventh.—To establish schools in which our members may study the highest branches of steam engineering.

MEMBERSHIP.

Candidates for membership must be citizens of the United States, of legal age, of good moral character, and sound of health and limb.

Applicants must have at least one year's active service as engineers, and where a license is required they must hold such license.

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The Publication Committee of "The Practical Engineer" desires that the Corresponding Engineers of all Councils of the American Order of Steam Engineers send the name of their Chief Engineer and their own name and address, together with the time and place of meeting to the Secretary of the Publication Committee immediately after each election of officers. Address J. C. McDowell, Secretary, in care of "The Practical Engineer," 1215 Filbert Street, Philadelphia.

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Continued on page 26.

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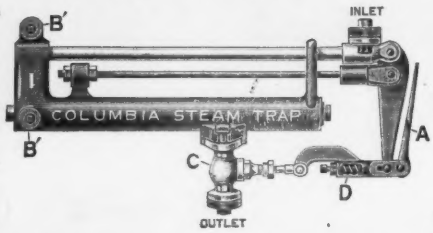

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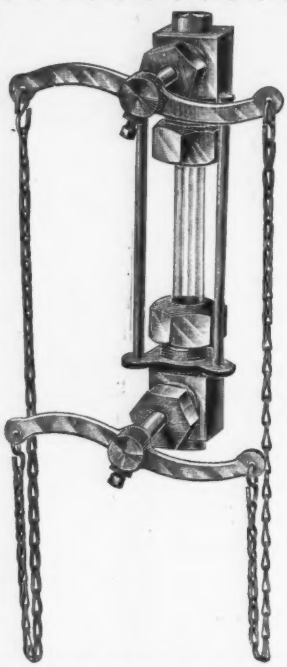

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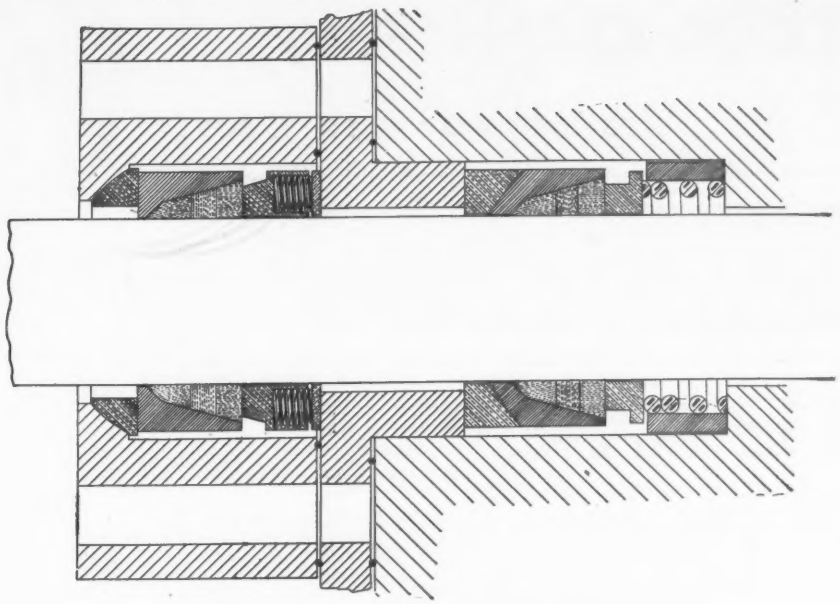

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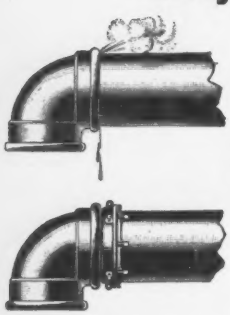

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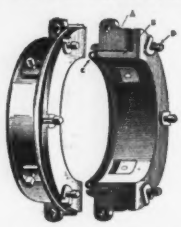

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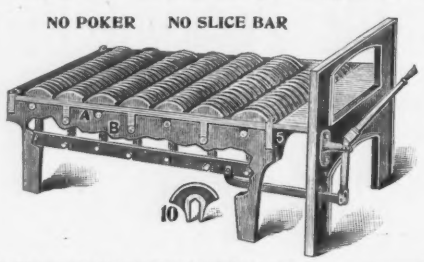

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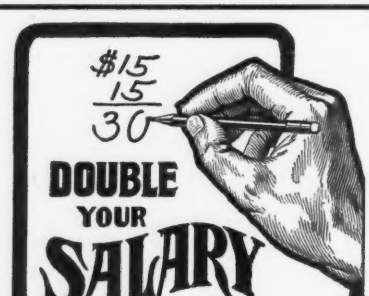

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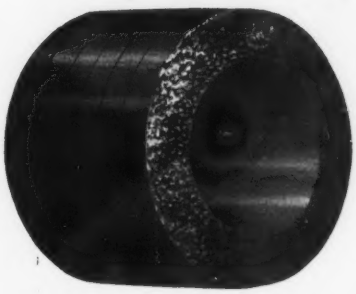

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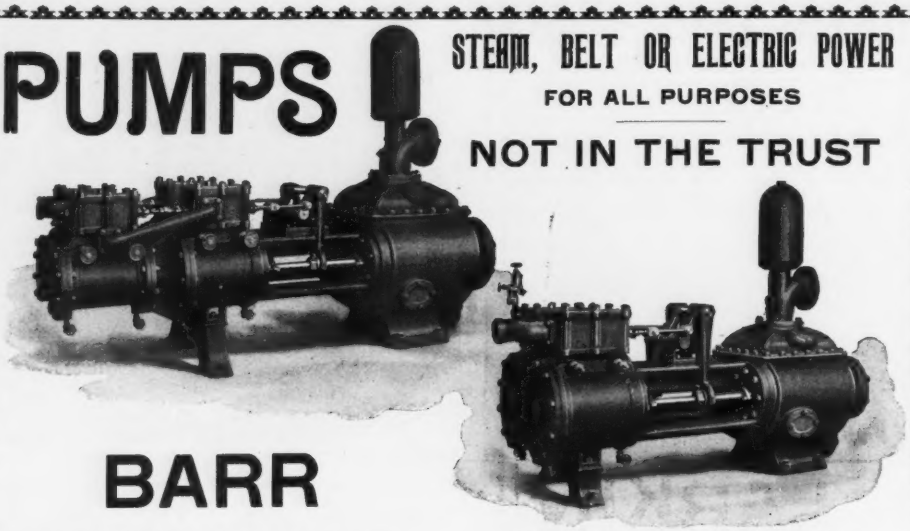

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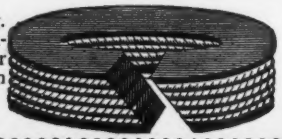

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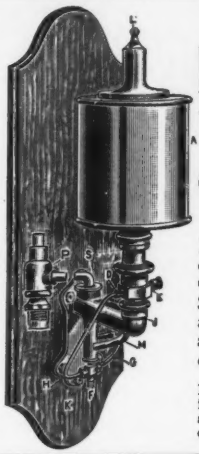

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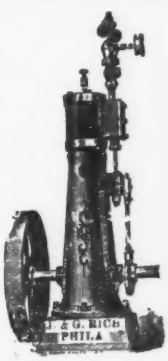

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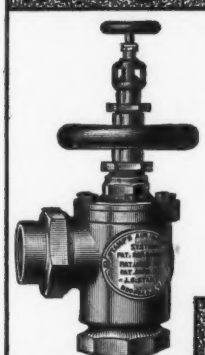

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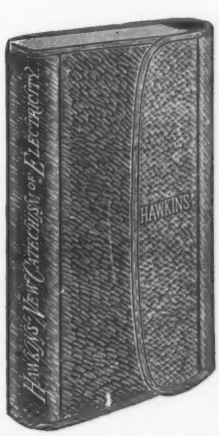

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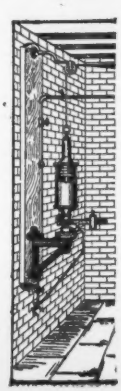

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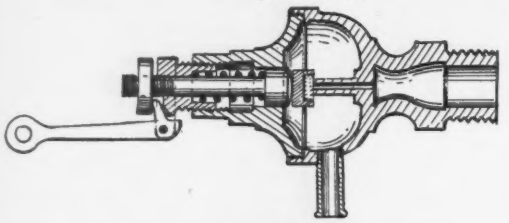

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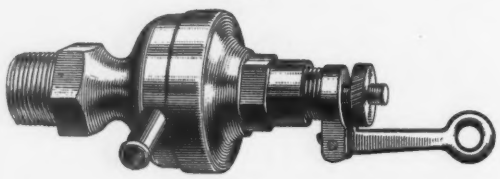

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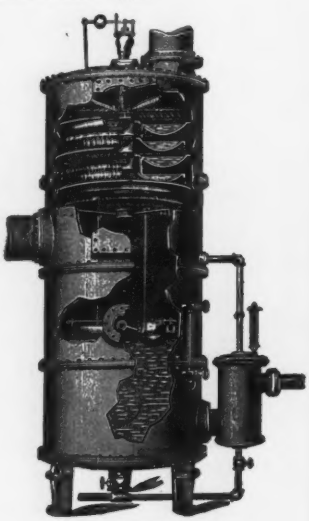

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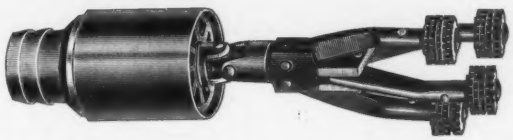

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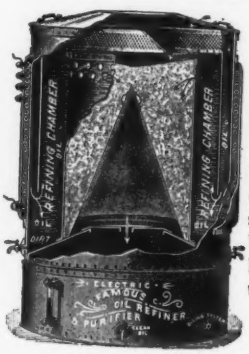

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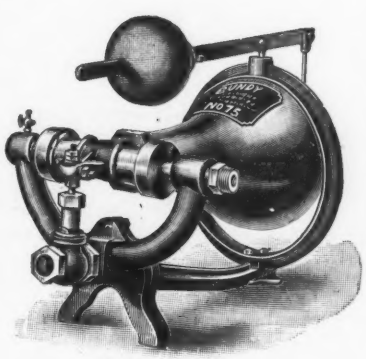

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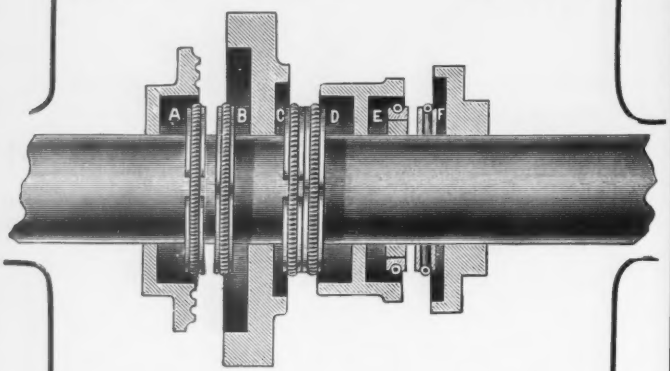

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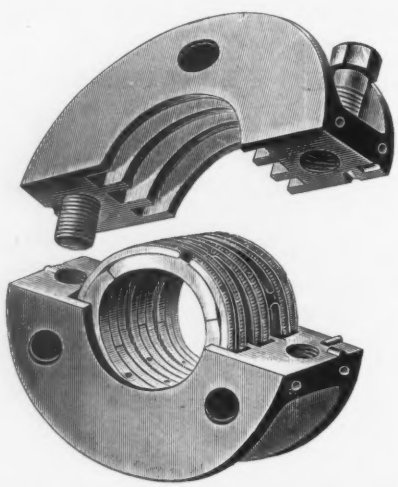

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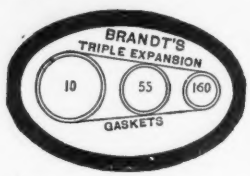

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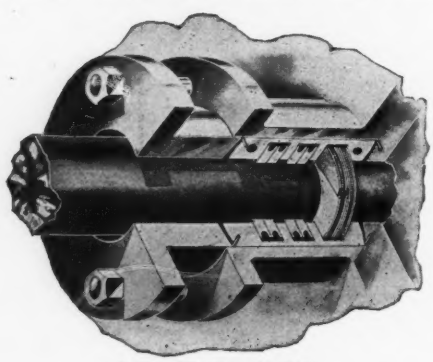

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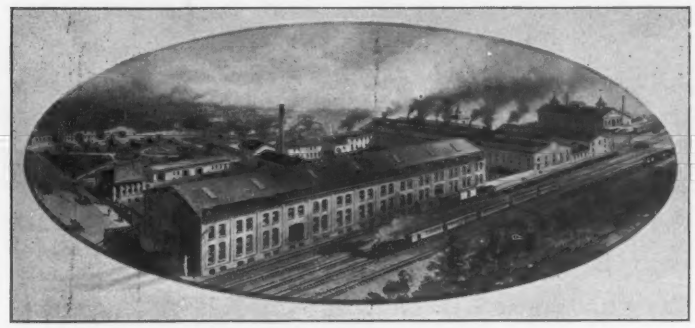

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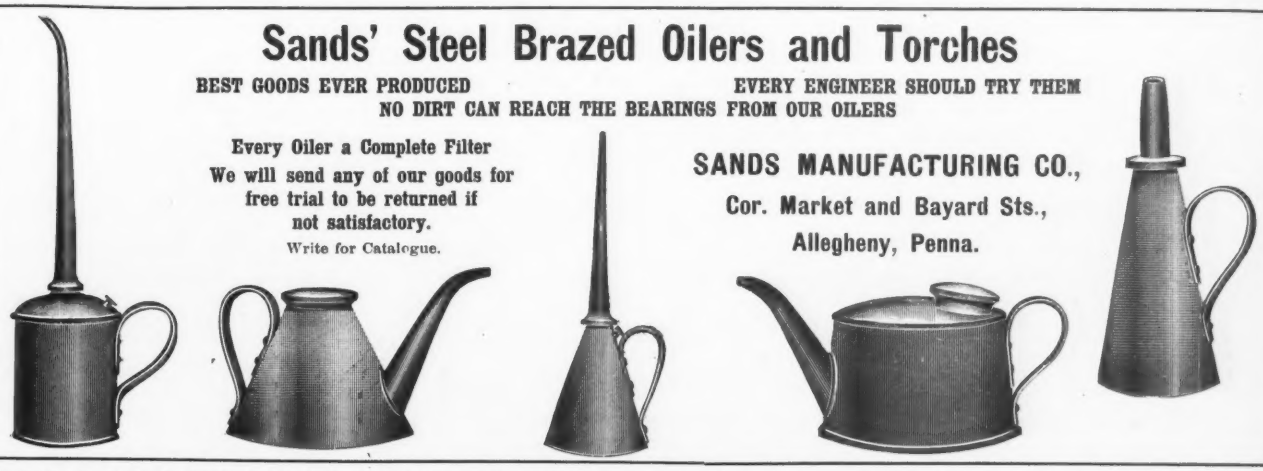

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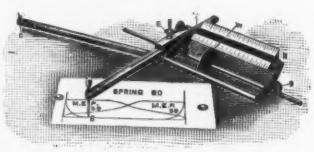

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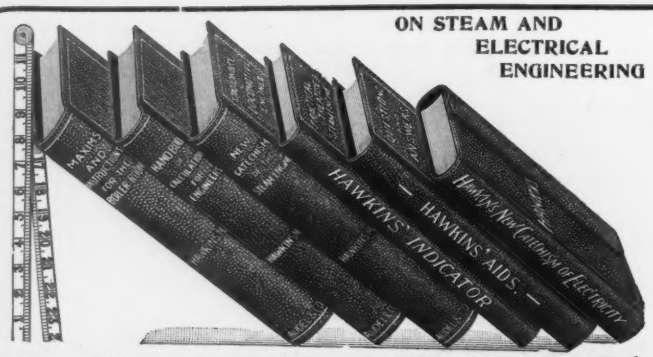

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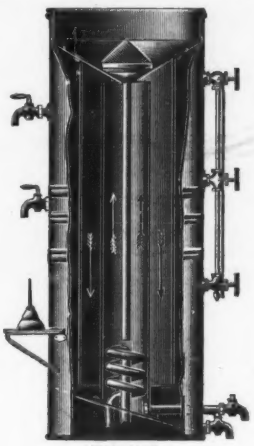

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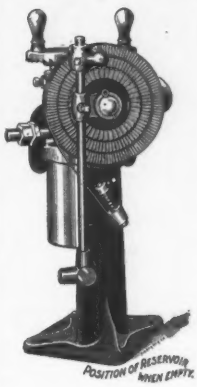

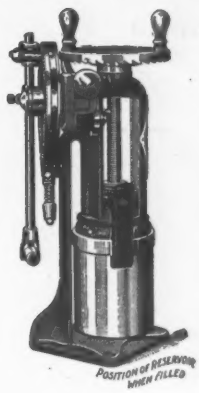

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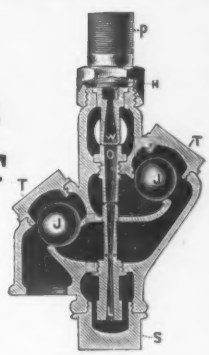

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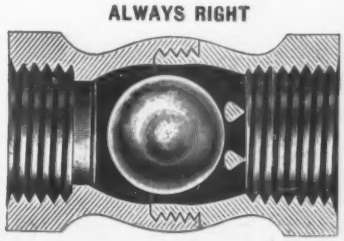

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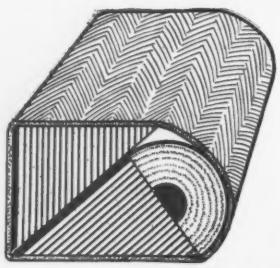

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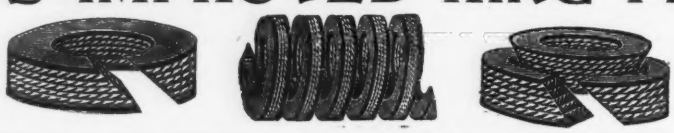

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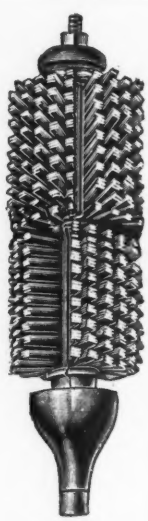

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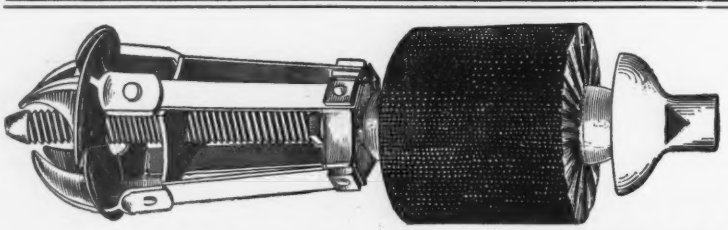

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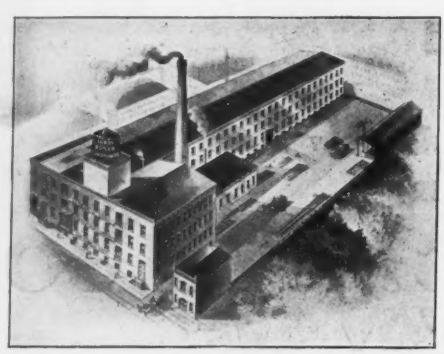

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Let every engineer make his own indicator book as he proceeds in his study and practice, and it will prove invaluable in after years. The present work has been compiled in this way, from data continually obtained during the author's professional career, extending over a third of a century.

The introduction of algebrical formules have been avoided. These are readily found in the many valuable mechanical pocket books. The writer has endeavored to discuss the principle and use of the indicator in as plain common sense words as the subject and the English language will admit of

Special attention has been given to the requirements of the young progressive student in steam engineering. The preparation of the following chapters has been a work of pleasure to the author, and if they prove beneficial to his fellow-workmen, he will be amply repaid.

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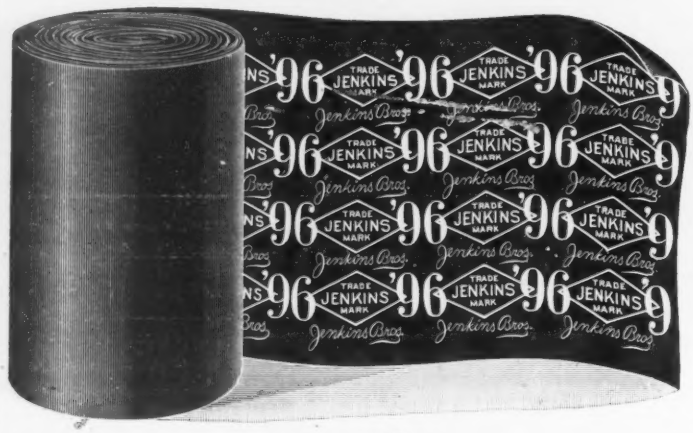

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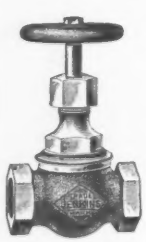

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